# MECHANICAL ENGINEERING

June 1959


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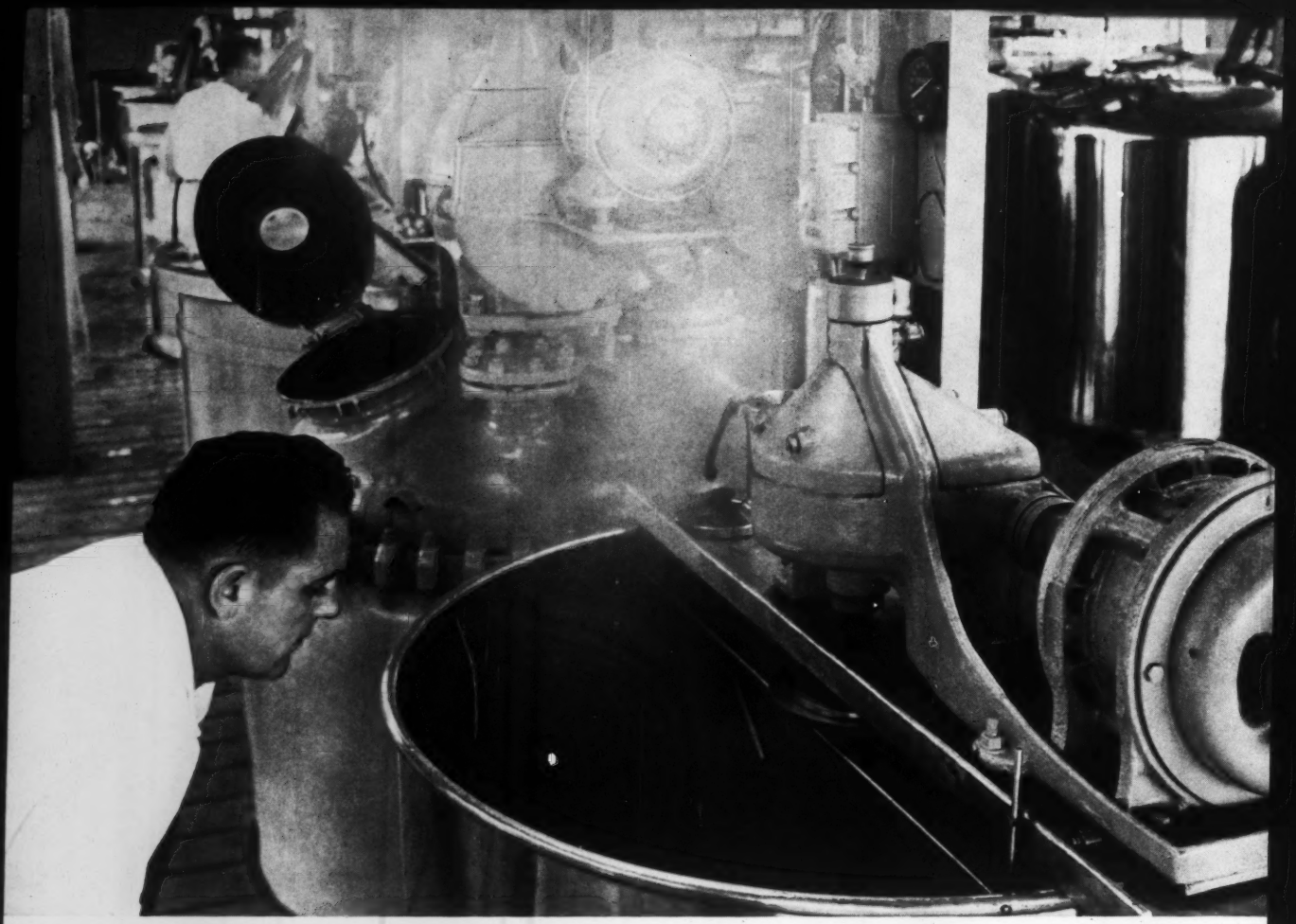


**Steam Supply by B & W**

# Keeps Boiler Room Hospital-Clean at Hoffmann-La Roche

## Pharmaceutical Manufacturer Meets Expanded Needs In Small Space

Spotless housekeeping, important throughout a pharmaceutical plant, was extended to Hoffmann-La Roche's boiler room at Nutley, New Jersey, when two new B&W units were installed. The new boilers meet expanding plant needs in a small space. They also take wide load variations in stride —on less fuel. Steam plays a multiple role in processing this famous line of pharmaceuticals, and the B&W Boilers provide a dependable, low cost supply of clean, dry steam.

**No matter how** you use steam, for processing or only for heating; no matter how large or small your demand is, it will pay you to look at your steam costs. You'll be surprised how much money you're burning. And that's the money that really matters —not the initial cost of the boiler.

**Most boilers** consume their initial cost in fuel every year. During the normal life expectancy of many boilers, the fuel bill can amount to several million dollars. Unless it is well-engineered, well-serviced, and well-maintained, the efficiency of a boiler can drop off 2 or 3 per cent or even more. This amounts to a substantial sum of money.

**You save** on your steam supply with B&W Boilers. That's why it pays to buy the best for your steam operations —B&W's top level engineering, long range sustained economy, and best performance. A national network of plants and engineers, supported by nearly a century of steam generating experience, is yours. Talk over your steam needs with B&W.

The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

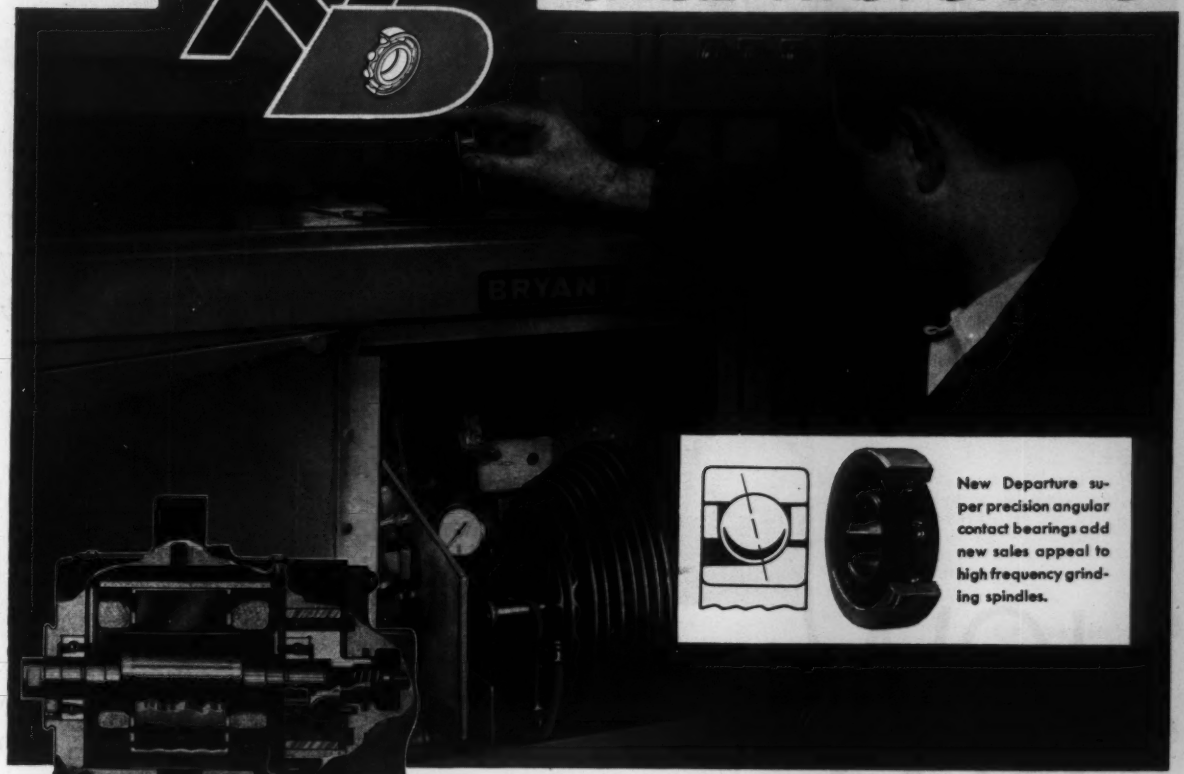
G-837-1B

B&W

THE BABCOCK & WILCOX COMPANY

*BOILER DIVISION*

CASE HISTORIES






New Departure super precision angular contact bearings add new sales appeal to high frequency grinding spindles.

Photo: Courtesy Bryant Chucking Grinder Co., Springfield, Vermont

# Ball Bearings Cut Costs $180.00 On 100,000 RPM Grinding Spindle!

**CUSTOMER PROBLEM:**

Machine tool maker experienced excessive assembly time with integral shaft type ball bearings in the production of 100,000-rpm grinding spindles for precision grinders. The ball bearing, with ground shaft serving as inner race, plus special balls, separator and outer race, required careful parts matching and assembly. Also, shaft and bearing replacement costs, if required, were high.

**SOLUTION:**

N/D Sales Engineer, in cooperation with the manufacturer, recommended using New Departure production ball bearings fitted directly to the shaft. These super precision, ultra high speed ball bearings eliminated the need for ball track grinding and delicate eccentricity matching at assembly. Using N/D ball bearings and engineering assistance, the manufacturer reduced parts and assembly costs $180 per unit. What's more, in the rare case of spindle damage, shaft assembly replacement costs have now been reduced $175 (over earlier models) . . . shaft assembly or bearings can be replaced separately, thanks to New Departure.

If you have new machine tool designs on the board, or are experiencing questionable costs in production, why not call on New Departure? There's probably a high precision N/D production ball bearing that can save you time or money! For more information, write Department U-6.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

A C-E Package Boiler, Type VP, en route to Europe. This boiler type is available with capacities from 4,000 to 90,000 lb of steam per hr, with pressures to 700 psi and temperatures to 750 F in certain sizes. It is designed for oil or gas firing. Several hundred of these units are now in service.

A shop-assembled Controlled Circulation Boiler, Type PCC, being prepared for shipment. This type unit is available with steam capacities from 80,000 to 120,000 lb per hr, and with pressures and temperatures to 1000 psi and 900 F. For special applications, designs are available to provide higher steam pressures and temperatures. Seven PCC Boilers are now in service.

A shop-assembled C-E High-Temperature Water Boiler, Type HCC, being unloaded at a midwest manufacturing plant. It is one of two 12-million-Btu boilers used for plant heating. Available for capacities from 10 million to 300 million Btu, this unit type is shop-assembled in sizes up to 50 million Btu for oil or gas firing—up to 40 million Btu for coal firing. Currently, more than 50 HCC Boilers are in service or on order.

# NOW C-E offers LARGER SHOP-ASSEMBLED BOILERS

## *Three service-proved designs with capacities to 120,000 lb per hr . . . pressures to 1000 psi . . . temperatures to 900 F*

The economies inherent in shop-assembled boilers can now be yours even if your steam requirements are as high as 120,000 lb per hr. The C-E line, consisting of three basic unit types, has been expanded to include pressures, temperatures and capacities well beyond normal package-type limits.

The standard, natural-circulation, ***C-E Package Boiler—Type VP***—is now available with capacities to 90,000 lb per hr, and with pressures and temperatures to 700 psi and 750 F.

Where greater steaming capacity is required, or where higher pressures or temperatures are needed for industrial processing or power generation, the shop-assembled ***C-E Controlled Circulation Boiler—Type PCC***—is available. It is designed for the 80,000-to-120,000-lb capacity range, with pressures to 1000 psi and temperatures to 900 F. For special applications, this unit is also available for considerably higher pressures and temperatures.

***The C-E High-Temperature Water Boiler—Type HCC***—is an ideal type for large space-heating and certain process uses. It is also available in shop-assembled form for capacities to 50 million Btu per hr. It is designed for pressures to about 500 psi, and can provide water at 450 F or higher.

The new, high-capacity ranges of these shop-assembled units represent the logical evolution of familiar and successful designs that have been proved in service for quality, economy and performance.

**Catalogs on any or all of these units available on request.**

**COMBUSTION ENGINEERING** C-E

C-202A

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.
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ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

MECHANICAL ENGINEERING

PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

# Contents

VOLUME 81 • NUMBER 6 • JUNE, 1959

EDITORIAL DEPARTMENT

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**THE COVER**

Wrap it up. Here, atomic fuel is sealed in a "bird-cage" container by an engineer at Atomics International, a Division of North American Aviation, Inc. Destination: An L-77 laboratory reactor at the University of Wyoming. The fuel consists of highly enriched uranium-235 in solution (uranyl sulfate) and will be used to start and run the reactor which was purchased from Atomics International for studies in physics, engineering, and chemistry.

**HUMAN ENGINEERING**.....**H. P. Van Cott** 50

Man brings just so much comprehension and dexterity to his work. The machine must not make impossible demands. How much sensing, data processing, and response can be asked of the operator?

**ELECTRONIC COMPUTERS FOR PETROLEUM** 53

**The Computer at Work**.....**R. J. Baxter**
**Technical Calculations**.....**W. S. Pickrell**
**Compressor Stations**.....**J. T. Manry, III**
**Natural-Gas Systems**.....**L. R. Henry and R. B. Peritz**
**Pipeline Investment**.....**T. R. Young**

Take a natural-gas system, say 200 wells. Design a trial network with compressor stations. Spend weeks in calculation. Now, try another layout. Now another. Hold it: We need a computer.

**A MAINTENANCE CONTROL CENTER**.....**L. G. Stine** 61

Ever try to cure "gold-plated maintenance"? You faced problems in organization, planning, scheduling, and assignment of work. Your objectives: Less down time, lower costs. Here's a new approach.

**EFFICIENCY AND SAFETY IN STAMPING PRESSES** 65

**Specification and Selection**.....**Carl Pearson**
**Safety**.....**Norman Dunlap**

Danger: Presses being purchased. Chosen unwisely, they can wreck the plant's economy. Poorly equipped, they maim their operators. Fisher Body and Minster Machine report on these powerful machines.

**EXTERNAL DEPOSITS AND CORROSION IN BOILERS AND GAS TURBINES**.....**B. A. Landry** 70

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**THE PROFESSION OF MECHANICAL ENGINEERING**.....**M. P. O'Brien** 74

Precisely what is a mechanical engineer, and what does he do? Our profession and our technical schools need a directive. The Dean of U. of C.'s College of Engineering offers his definition.

**EDUCATION IN TRANSITION**.....**J. H. Keenan** 76

The scientist has been closing the gap between the known and the unknown. Now we need engineers with the imagination, intuition, and judgment to fulfill the promise of the scientific age.

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## How B&W JOB-MATCHED EXTRUSIONS can reduce the cost of your finished product

. . . they meet your design and production requirements because the extrusion process can produce a variety of shapes in solid or tubular form

. . . they meet product end-use specifications because you have a choice of high-alloy and stainless steels, or special non-ferrous metals and alloys

. . . they save production time because operations can often be reduced to a mere cutting to length and a few simple finishing operations

Be sure it's B&W when you specify extrusions. Call your local B&W District Sales Specialist, or write for Bulletin TB-413 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W

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***TUBULAR PRODUCTS DIVISION***

TA-9004-E1

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

MECHANICAL ENGINEERING

PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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62,000 copies of this issue printed

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# Exacting Requirements?

**for PRECISION . . . specify**

# ACIPCO

## *CENTRIFUGALLY SPUN STEEL TUBES*

For almost 80 years, Morton Manufacturing Company of Muskegon Heights, Michigan, has been progressively building bigger and better machine tools.

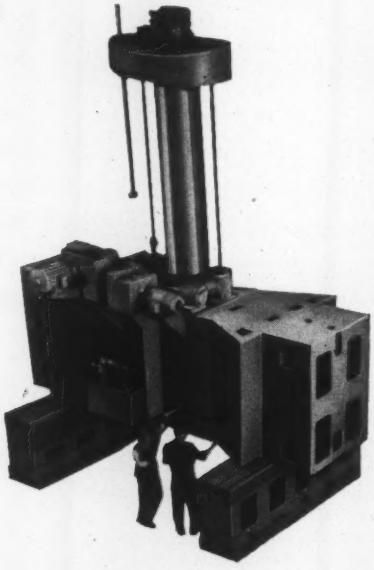
This ultra-modern turning and boring mill is 27 feet x 22 feet x 40 feet high, and weighs 525,000 pounds. Load capacity is 120,000 pounds. Driven with 210 horse-power, it is the first machine of its type wherein the work remains stationary.

Because of the herculean task this machine must perform, each component must be capable of precise performance under extreme loads. Morton wisely selected ACIPCO centrifugally spun steel tubing for the gigantic quill which houses and guides the rotary spindle. This tube is 24″ in diameter, 3″ in wall thickness and 17′6″ long.

ACIPCO centrifugally spun tubes have a dense, non-directional grain structure that has extra-ordinary strength and durability, and is more easily machined to close tolerances.

Whatever you may have in tubular applications, call on ACIPCO for perfect dependability. Our technical and manufacturing competence will serve your exacting needs.

**MORTON**



Morton Manufacturing Company, of Muskegon Heights, Michigan, is a leading manufacturer of heavy duty machinery for the machine tool industry. Boring mills; drillers, planers, as well as special machine tools for national defense and the development of new processes are among their products.

### ACIPCO Centrifugally Spun TUBES

**SIZE RANGE:** Lengths up to 410″ have been produced to meet modern machinery requirements. OD'S from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

**ANALYSES:** All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special analyses.

**FINISHED:** As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.

**SPECIAL PRODUCTS DIVISION**

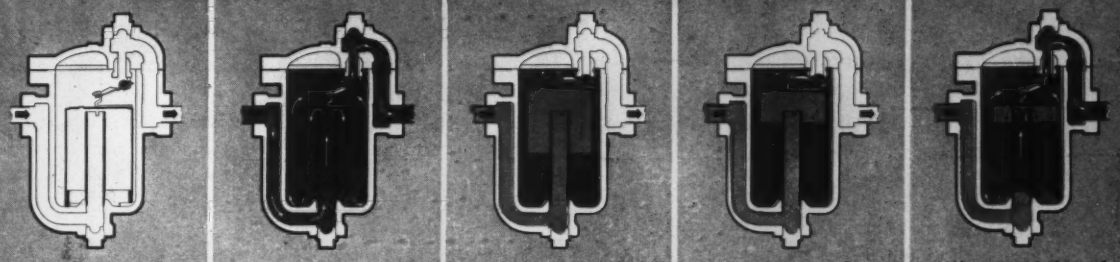
**AMERICAN**

CAST IRON PIPE CO.

BIRMINGHAM 2, ALABAMA

ACIPCO

## This simple trap operating principle provides the efficiency, dependability and freedom from maintenance necessary for the most profitable use of steam



When trap is first installed, the inverted bucket is down and the valve is wide open.

When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until —

Steam (light color) reaching the trap floats the inverted bucket and closes the valve.

When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

Key: condensate steam steam bubbles air bubbles

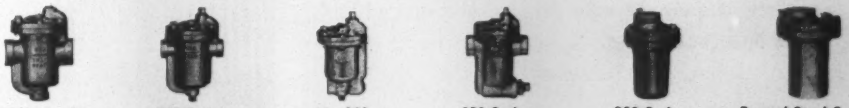
# ARMSTRONG INVERTED BUCKET STEAM TRAPS

## are designed and made to give you these big benefits:

● Amstrong Traps, the first inverted bucket steam traps, now represent the most advanced development of this time-proven principle. They provide all the advantages necessary for efficient, economical condensate drainage from virtually all types of steam using equipment.

1. *No steam loss* – Steam never reaches the orifice even when there is no condensate load.
2. *Automatic air elimination* – Vent in trap bucket passes air and other non-condensibles through to be discharged with condensate.
3. *No cooling leg required* – Condensate is discharged at steam temperature as fast as it reaches the trap because trap operates on difference in density between steam and water not on temperature.
4. *Operates on any back pressure* – Failure of one trap in system will not cause others to open because high back pressure does not affect an Armstrong trap other than to reduce capacity. As long as there is a pressure differential across the orifice the trap will close on steam and open for condensate.
5. *Unaffected by ordinary dirt* — Swirling action of condensate keeps dirt in suspension until discharged with condensate, prevents it from lodging in valve.
6. *Completely dependable* — Proved design plus the use of all stainless steel working parts assure continuity of service and length of service unmatched by any other trap.
7. *Big capacity in a small, economical package* — Armstrong design gives you the highest practical capacity for any given pressure. And remember, Armstrong capacity ratings are based on *hot* condensate at the *working pressure differential* stated, not on theoretical orifice capacities.

Further information on these advantages plus much additional information is given in the 48 page Armstrong Steam Trap Book. Ask your local Armstrong Representative or write direct.



860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

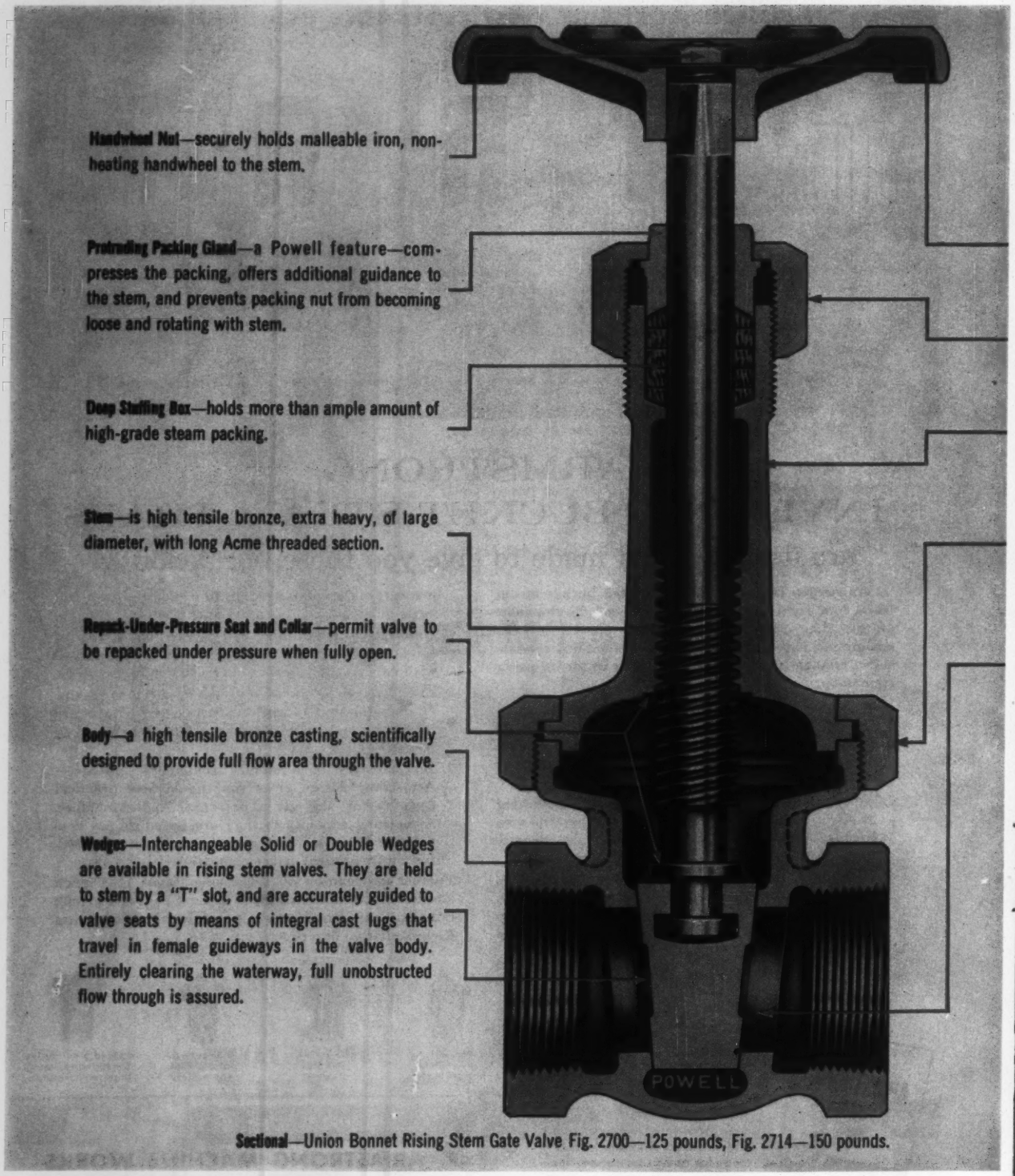
Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

**ARMSTRONG MACHINE WORKS**

**8943 Maple Street • Three Rivers, Michigan**

# ANNOUNCING NEW **POWELL**


**Handwheel Nut**—securely holds malleable iron, non-heating handwheel to the stem.
**Protruding Packing Gland**—a Powell feature—compresses the packing, offers additional guidance to the stem, and prevents packing nut from becoming loose and rotating with stem.
**Deep Stuffing Box**—holds more than ample amount of high-grade steam packing.
**Stem**—is high tensile bronze, extra heavy, of large diameter, with long Acme threaded section.
**Repack-Under-Pressure Seat and Collar**—permit valve to be repacked under pressure when fully open.
**Body**—a high tensile bronze casting, scientifically designed to provide full flow area through the valve.
**Wedges**—Interchangeable Solid or Double Wedges are available in rising stem valves. They are held to stem by a "T" slot, and are accurately guided to valve seats by means of integral cast lugs that travel in female guideways in the valve body. Entirely clearing the waterway, full unobstructed flow through is assured.
POWELL

**Sectional**—Union Bonnet Rising Stem Gate Valve Fig. 2700—125 pounds, Fig. 2714—150 pounds.

**POWELL...world's largest family of valves**

# BRONZE UNION BONNET GATE VALVES

## for 125 and 150 pounds WSP

**These new BRONZE Union Bonnet Gate Valves have many superior features—some of which are outlined here. For complete details, write for new illustrated circular. Or check with your nearest Powell Valve distributor.**

**Identification Plate**—gives Figure Number and kind of valve.

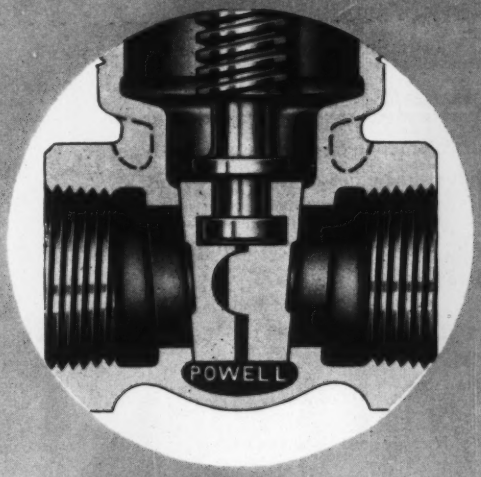
**Heavy Hexagonal Packing Nut**—for holding gland and adjusting packing.

**Long Bonnet**—cast of high tensile bronze for long service.

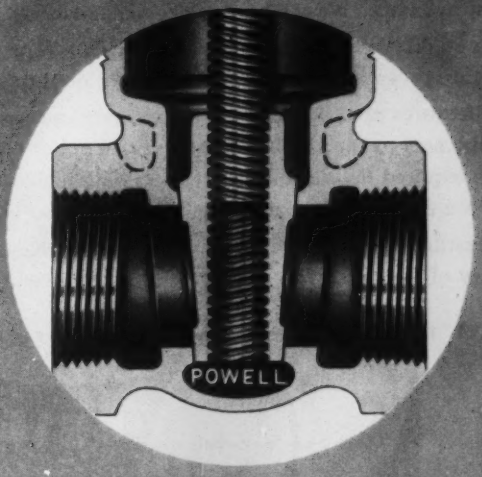
**Octagonal Ring Nut**—is deep threaded and tightly holds body-bonnet connection. Affords additional wrenching positions.

**Ample Space**—between seats and end of pipe thread prevents injury to seats when screwing pipe into the body.

**Fig. 2707**—125-pound Union Bonnet Non-Rising Stem Gate Valve. Aiso available for 150 pounds—Fig. 2712.

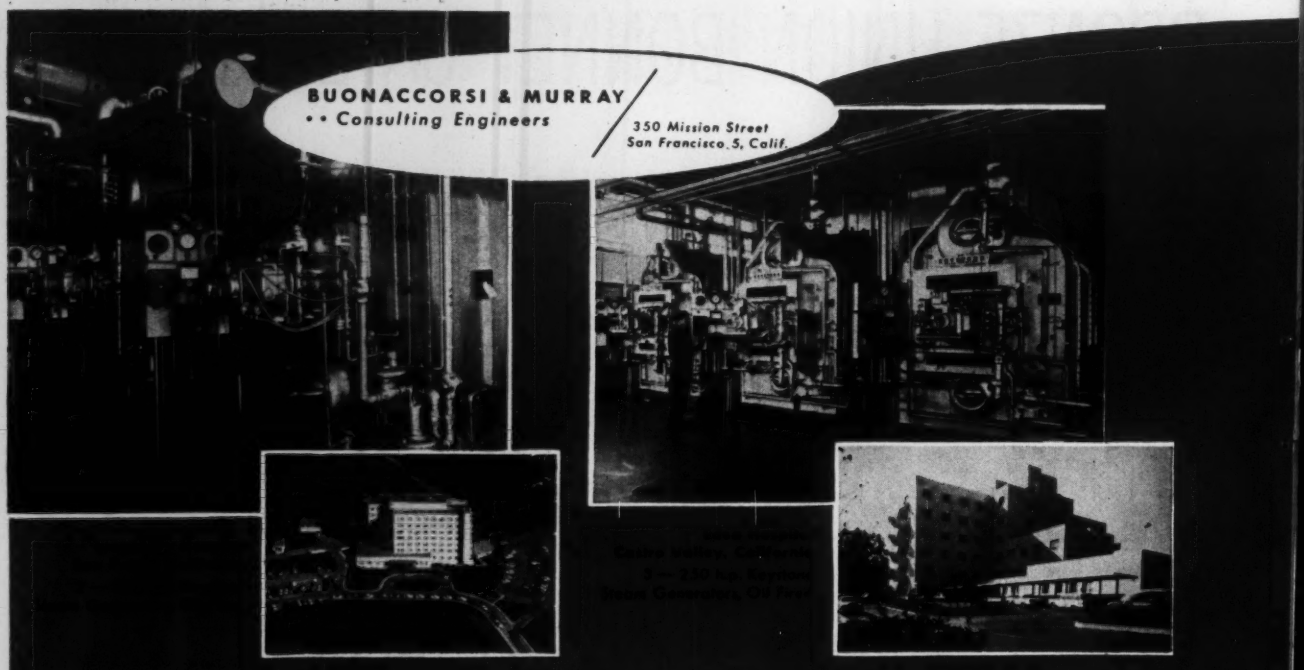



Detail of Sectional View Inside Screw Rising Stem Gate Valve showing Double Wedge Disc and Integral Seats.




Detail of Sectional View Non-Rising Stem Gate Valve showing Solid Wedge Disc that rises on stem. Integral Seats.

**THE WM. POWELL COMPANY** • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**




# *Professionals choose* ERIE CITY KEYSTONE STEAM GENERATORS

● Consulting Engineers and their staffs are actively engaged in selecting and coordinating the most dependable equipment available. We are proud of the confidence they have placed in Erie City.

Built-in quality is the backbone of confidence — and hundreds of Keystone Steam Generators are in service today because they incorporate proven quality design features.

Design features such as tangent furnace and outer wall tubes plus double steel encased insulation keep outer casing cool to the touch. The top smoke outlet eliminates the inconvenience of a hot stack in the aisle, minimizes required floor space and reduces building costs. Keystones have no baffles or headers which generally are a source of troublesome maintenance.

These features and many more have proved the Keystone to be a safe, highly efficient steam generator with plenty of reserve power. Write for our comprehensive Bulletin SB-5994-F.

**LOW EXIT TEMPERATURES AND HIGH EFFICIENCIES ARE STANDARD WITH THE KEYSTONE**

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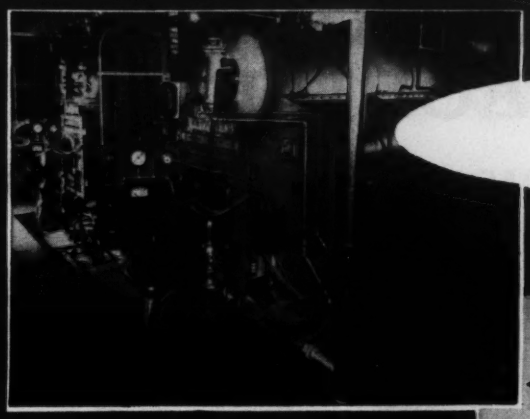

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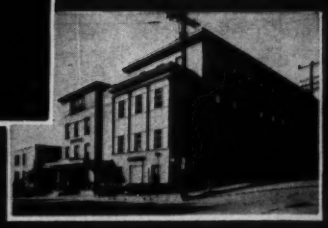

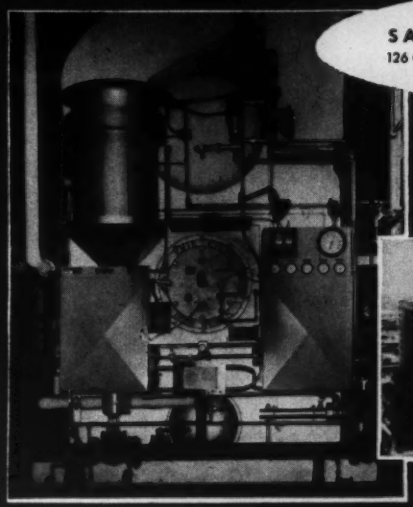

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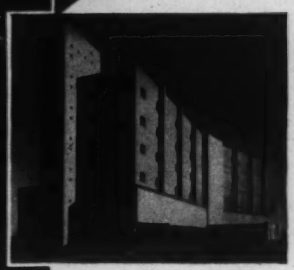
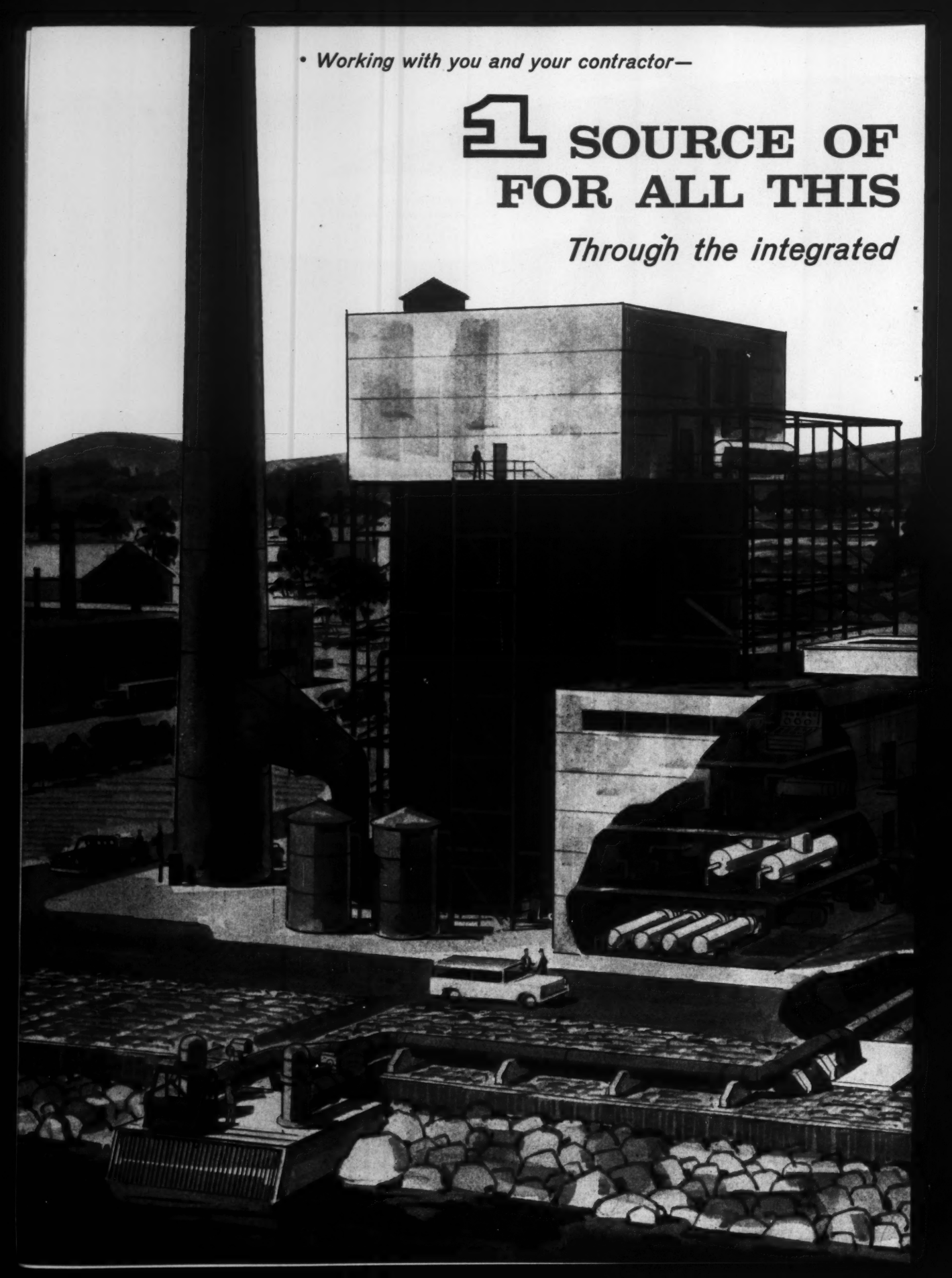
**0 h.p. Keystone Steam**
**rators, Gas Fired**





• *Working with you and your contractor—*

# 1 SOURCE OF FOR ALL THIS

*Through the integrated*

# SUPPLY 1 RESPONSIBILITY POWER PLANT EQUIPMENT

## *facilities of YUBA—NATIONWIDE to serve you best*

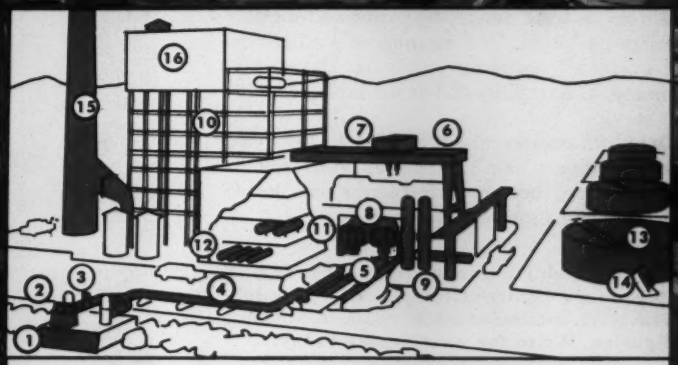
The problem of coordinating all the purchases and delivery of specialized equipment for steam plants can be greatly simplified—when it is packaged as a single responsibility with Yuba.

The advantages to you, your consultants and your contractor are many. They can easily add up to major savings in time, money and trouble. The experienced Yuba organization is geared to deliver a fully integrated service every step of the way: through equipment design, engineering, manufacturing, installation and erection.

Operating nationwide, the divisions and manufacturing plants of Yuba serving the power industry are ideally equipped and located to maintain the highest product quality standards and meet the most demanding completion dates—economically.

Call in your Yuba man. Discuss your plans and problems with him. See how your job can be made easier with his and Yuba's help.

*DIVISIONS AND SUBSIDIARIES SERVING THE POWER INDUSTRY: Yuba Heat Transfer Division • Adsco Division • Yuba Manufacturing Division • Southwest Welding & Manufacturing Division • Judson Pacific-Murphy Division • Yuba Consolidated Erectors, Inc.*




**YUBA PRODUCTS FOR STEAM POWER PLANTS**

1. Intake gates
2. Trash racks and rakes, guides
3. Butterfly valves
4. Penstocks
5. Expansion joints
6. Gantry or semi-gantry cranes
7. Hoists
8. Surface condensers
9. Feedwater heaters
10. Structural steel work
11. Evaporators
12. Fuel oil preheaters
13. Oil storage tanks
14. Tank suction heaters
15. Steel stacks
16. Surge tanks

*A print of this power plant artwork, suitable for framing, is available free of charge. Write Yuba Consolidated Industries, Inc., Dept. MF, 351 California St., San Francisco, California*

YUBA

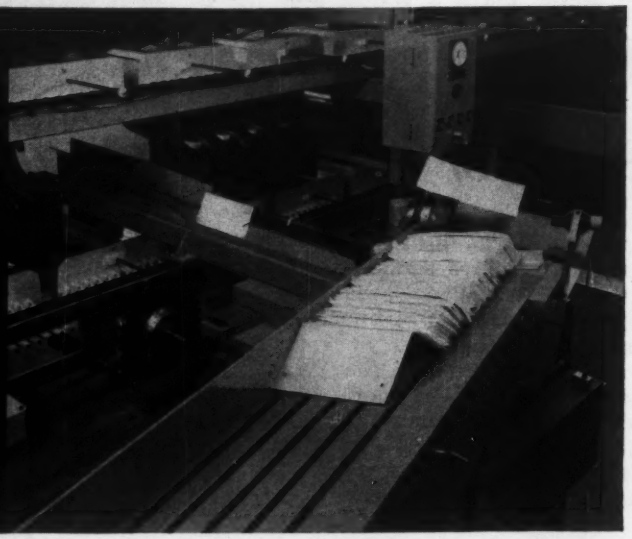
**YUBA CONSOLIDATED INDUSTRIES, INC.**

*351 California St., San Francisco, California*

## You can solve many problems **better** and at **lower cost** with DIAMOND Roller Chain

Complex Automated Equipment for Post Office Department is Synchronized by

# DIAMOND Roller Chain



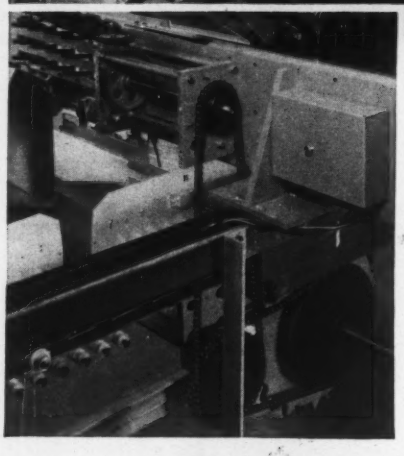
Five parallel strands of DIAMOND Roller Chain feed code-marked letters to an electronic decoder which presets the "memory wheel" codes attached to letter baskets. Letters are automatically fed to the baskets by a second DIAMOND-equipped conveyor.

The main conveyor consisting of partitioned baskets suspended between parallel strands of DIAMOND Conveyor Chain, passes over rows of "destination" bins and deposits each letter in its appropriate bin in response to the preset arrangement of the "memory wheels."

● Labor-saving equipment developed for the Post Office Department by the Rabinow Engineering Company, Washington, D. C., uses DIAMOND Roller Chain exclusively for power transmission, conveying and to synchronize the machine's multiple operations.

The smooth coordination of the several functions performed by this one machine demonstrates the adaptability of DIAMOND Roller Chain to a wide range of power-and-motion transfer problems. The equipment's efficiency and operating economy testify to DIAMOND's accuracy, its durability and dependable, trouble-free service.

DIAMOND engineers will be glad to help you work out roller chain drives that will result in better design, better performance and lower operating costs for *your* product.



Single Strand DIAMOND Roller Chains synchronize the many conveying, timing and selective movements required to sort mail rapidly and accurately in Rabinow's automated equipment.

**DIAMOND publishes a complete library of roller chain information for design engineers . . . available upon request, without obligation. Write for your copies today.**

**DIAMOND CHAIN COMPANY, Inc.**

*A Subsidiary of American Steel Foundries*

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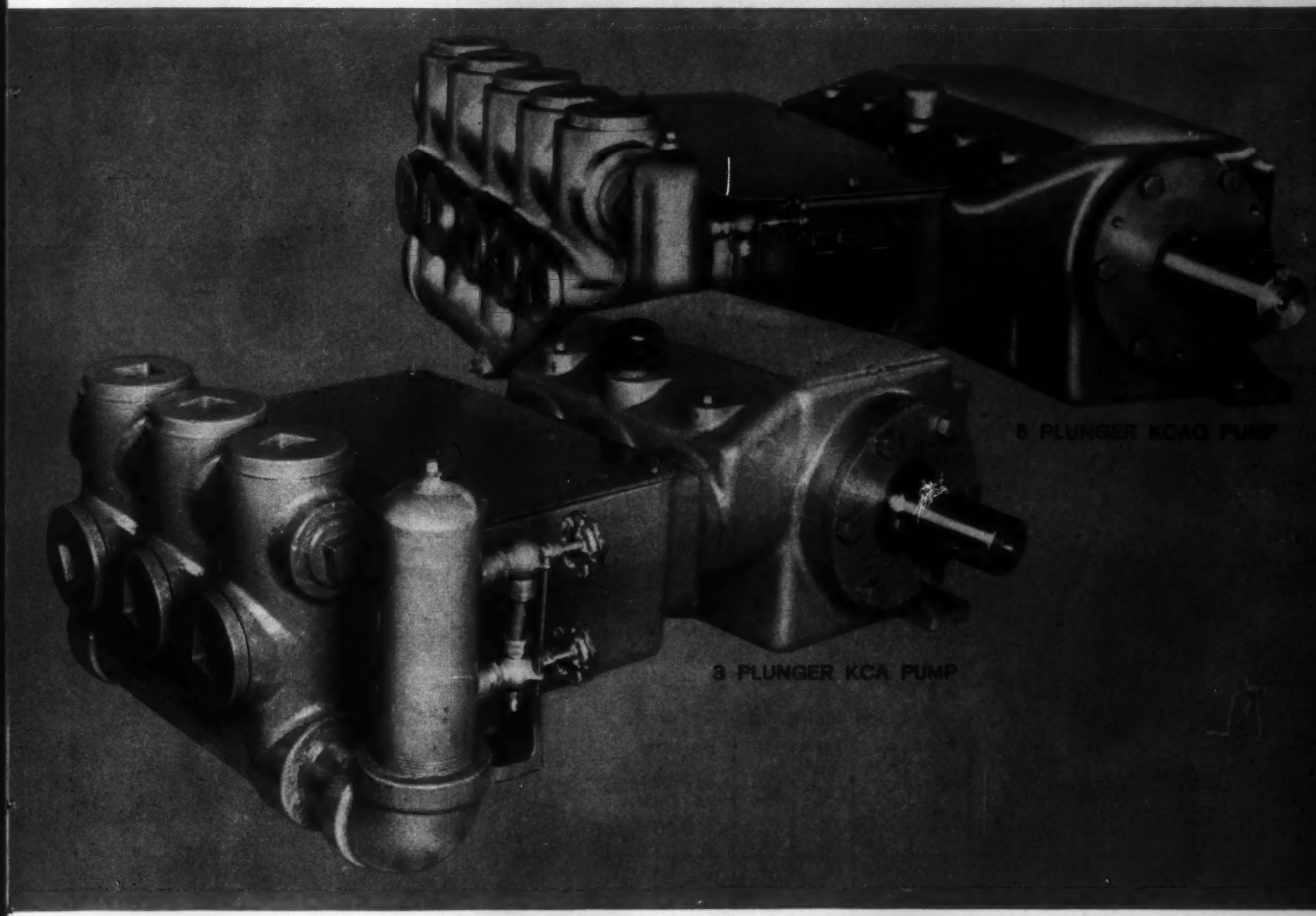
DIAMOND ROLLER CHAINS

# Introducing: 2 NEW HIGH PRESSURE PUMPS AT 2 NEW LOW PRICES




Before you buy a high pressure pump for your hydraulic application, see Worthington's new KCA and KCAQ pumps. You can depend upon these two new pumps to give you highest capacity and most pressure at truly low prices.

These horizontal power pumps save you up to 53% on initial cost. Some of the many applications for the KCA and KCAQ units include hydraulic presses and shears, steel mill roll balance, die casting, boiler feed service, descaling, cleaning and washing, fog spraying, hydrostatic testing, and rifle drilling coolants.

The KCA and KCAQ pumps have 6 outstanding features:

**1. Meets wide range of conditions.** Plunger diameters can be varied from 1¼ to 2½ inches.

**2. Fewer Spares to carry**—Wearing parts interchangeable between KCA and KCAQ pumps.

**3. Many "extras" included as standard** such as solid ceramic or Colmonoy plungers, suction air chamber to minimize noise and pulsation, plunger packing and stuffing box cover.

**4. Flooded suction adequate** because large pipe connections minimize friction. KCAQ has 4″ suction, 3″ discharge on either side. KCA has 3″ suction, 3″ discharge on either side.

**5. Less valve wear** resulting from guided, wing-type valves that are self-grinding. Liberally-sized suction and discharge valves both removable through single top covers.

**6. No shaft deflection problems.** Extra heavy crankshaft has *all* roller bearings.

For complete information, get in touch with your nearby Worthington representative. Or write to Worthington Corporation, Section 32-4, Oil City, Pa. In Canada: Worthington (Canada) Ltd., Brantford, Ont.

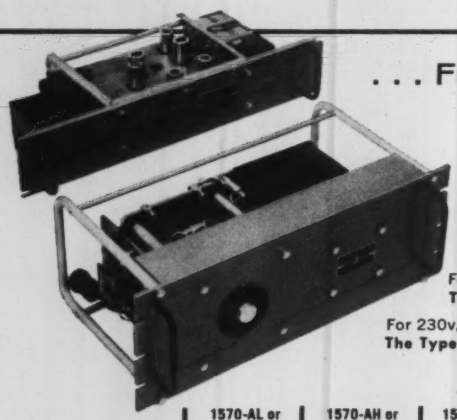
WORTHINGTON

# 50 ampere

## Servo-Type **LINE-VOLTAGE REGULATOR**

- ★ Handles up to 500 Amperes on Short-Period Overload
- ★ Holds Line Voltage Constant to ±0.25%
- ★ *NO* Waveform Distortion
- ★ *NO* Power Factor Restrictions
- ★ *NO* Relays to Cause Transient Pulses or Chattering
- ★ Can Be Connected to Handle 10% or 20% Line-Voltage Variations
- ★ Output Voltage Can be Varied ±10% from Nominal Voltage
- ★ All in a 0.9 Cubic-Foot Package

For 115v, 60-cycle lines **The Type 1570-AL . . . $490**
For 230v, 60-cycle lines **The Type 1570-AH . . . $510**
50-cycle models are available



## . . . Fully Militarized Regulators with Separate Control and Regulator Units

**same features as standard model plus:**

- ★ Meet Requirements of MIL-E-4158B and MIL-E-16400
- ★ Easy to Maintain . . . All Circuits Readily Accessible
- ★ Highest Reliability Components Throughout

For 115v, 45-55- and 55-65-cycle lines
**The Type 1570-ALS15 . . . $670**

For 230v, 45-55- and 55-65-cycle lines
**The Type 1570-AHS15 . . . $690**

| Type Number | 1570-AL or 1570-ALS15 115v | | 1570-AH or 1570-AHS15 230v | | 1570-ALS25 115v, 3 phase | | 1570-AHS25 230v, 3 phase | |
|---|---|---|---|---|---|---|---|---|
| Correction range in percent of output voltage | 1570-AL ±10% / 1570-ALS15 ±9% | 1570-AL ±20% / 1570-ALS15 ±18% | 1570-AH ±10% / 1570-AHS15 ±9% | 1570-AH ±20% / 1570-AHS15 ±18% | ±9% | ±18% | ±9% | ±18% |
| Output current in amperes | 50 | 25 | 20 | 10 | 25 (Output current per phase) | 12.5 (Output current per phase) | 10 (Output current per phase) | 5 (Output current per phase) |
| KVA | 5.75 | 2.9 | 4.6 | 2.3 | 8.6 wye connected: / 5 delta connected: | 4.3 wye connected: / 2.5 delta connected: | 6.9 wye connected: / 4 delta connected: | 3.5 wye connected: / 2 delta connected: |
| Correction accuracy in percent of nominal output voltage | ±0.25% | ±0.5% | ±0.25% | ±0.5% | ±0.25% | ±0.5% | ±0.25% | ±0.5% |
| Correction speed in volts per second | 10 | 20 | 20 | 40 | 5 | 10 | 10 | 20 |

***New***

**THREE-PHASE MILITARIZED MODEL FOR REGULATION OF BALANCED SYSTEMS**

A three-gang motor-driven Variac controls three phases simultaneously in response to variations occurring in one phase. Where balanced lines or loads are not available, three single-phase 1570-A Regulators should be used.

For 115v, 45-55- and 55-65-cycle lines
**The Type 1570-ALS25 . . . $865**
For 230v, 45-55- and 55-65-cycle lines
**The Type 1570-AHS25 . . . $885**

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*To Our New Plant and Main Offices*

***Write For Complete Information***

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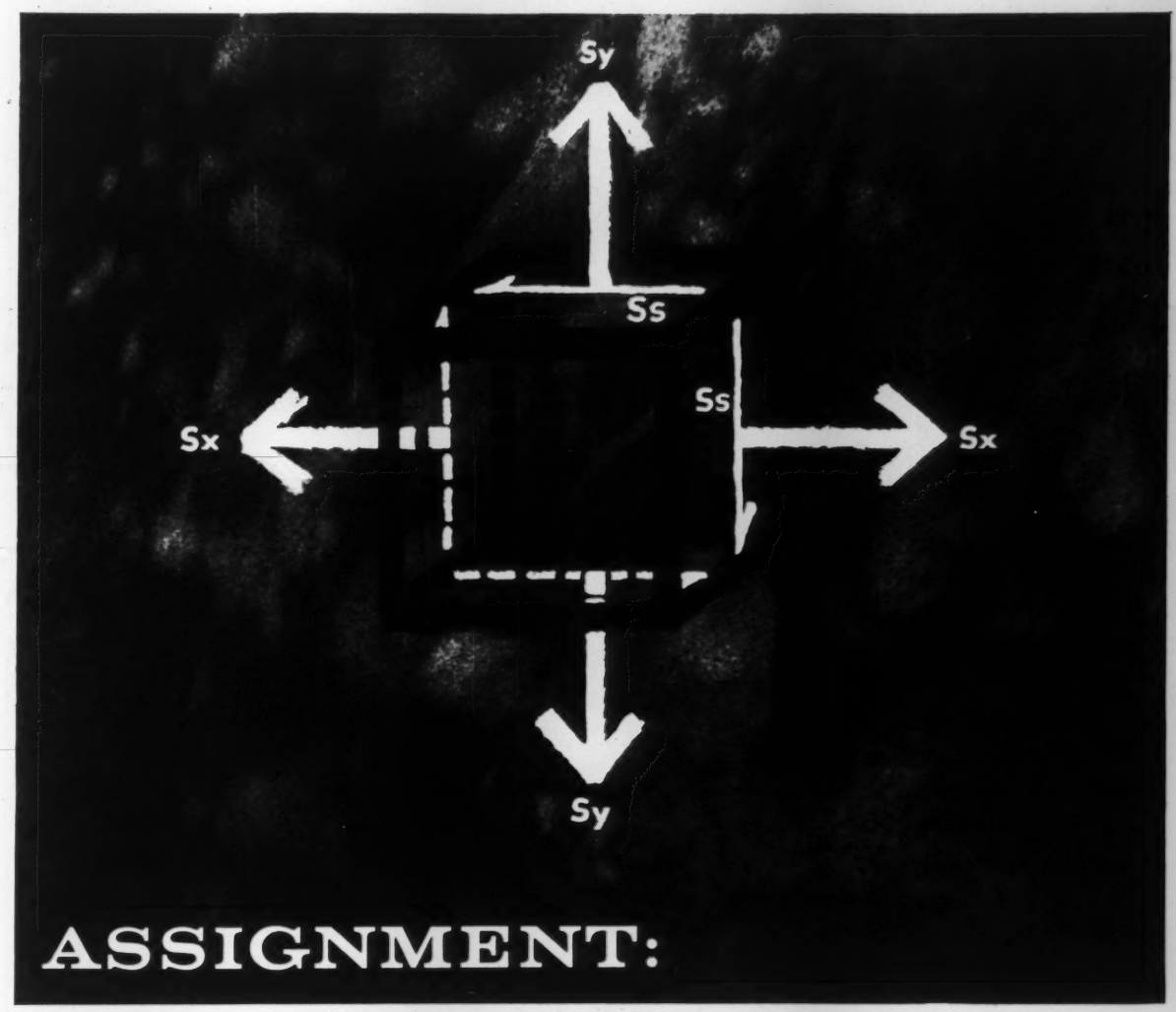



# ASSIGNMENT:

# ABRASIVE IMPACT

## How Lukens *Application Research* helps you find the right steel plate for the job

If your assignment is designing equipment to withstand abrasive impact, our Application Engineering staff can serve you. Their specialty is helping you track down the precise steel plate for any job. They research a problem from the design stage right through to how the equipment has performed for years after its installation. This practical observation and experience—combined with metallurgical know-how—is yours for the asking. It's been saving our customers money for years.

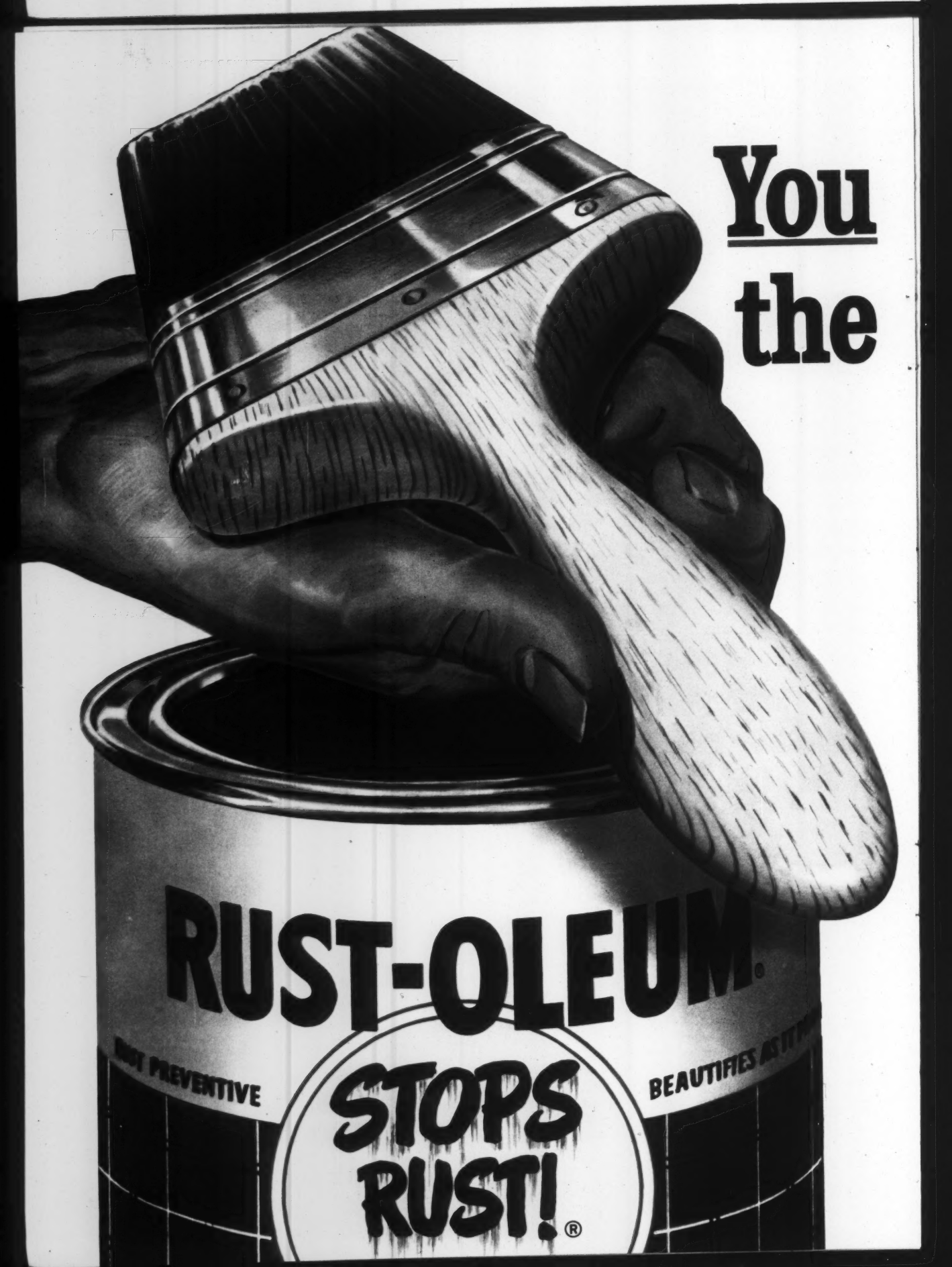
For example: working recently with a conveyor engineer, our people showed why 321 min. BHN quality Lukens "T-1" would perform equally as well as a previously used metal costing twice as much. On the other hand, the same group has suggested the regular quality of Lukens "T-1" for a uranium mine skip hoist, where a slightly softer steel will actually hold up longer. In still another conveyor application—in a coal preparation plant—our engineers demonstrated how stainless steel, Type 304, would produce long-term savings. The high initial cost of stainless was reduced by using it in Lukens clad plate form.

*If your assignment is abrasive impact, why not let it be our assignment, too?* Contact Manager, Application Engineering, G69 Services Building, Lukens Steel Company, Coatesville, Pa. Also ....

**Helping Industry Choose Steels That Fit The Job**

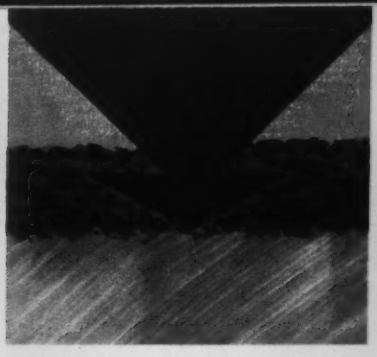
LUKENS

**ASK FOR LUKENS "T-1" STEEL BULLETIN**


You
the
RUST-OLEUM®
RUST PREVENTIVE
STOPS
RUST!®
BEAUTIFIES AS IT

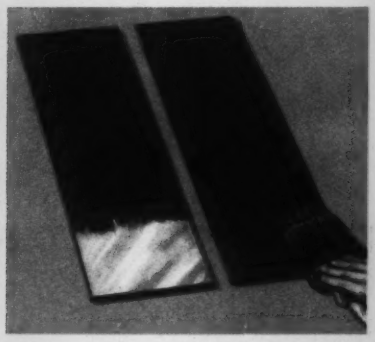
# take brush!

Apply Rust-Oleum 769 Damp-Proof Red Primer directly over sound rusted surfaces. Saves costly surface preparations—lasts and lasts.



The **specially-processed** fish oil vehicle in the primer penetrates rust to bare metal—as proved in radioactive tracing studies.

Rust-Oleum, in its many forms, resists rain, fumes, heat, moisture, sun, and general weathering to stand up over the years.



Up to 30% more coverage with Rust-Oleum, depending upon the condition and porosity of the surface. Another Rust-Oleum difference.

## See the many Rust-Oleum DIFFERENCES yourself!

Rust-Oleum primers and finish coatings are easily applied by spray. Flows smoothly . . . may be used in conventional, hot spray, or high pressure air-less spray.

A few easy strokes of the brush proves more than a thousand words . . . see how smoothly Rust-Oleum flows on . . . no pull, no drag . . . and it dries free of brushmarks. See, too, how much more coverage Rust-Oleum gives you . . . up to 30% more area depending upon the condition and porosity of the surface.

If your metal surfaces are *rusty* – simply brush or spray Rust-Oleum 769 Damp-Proof Red Primer right over the sound rusted metal after scraping and wirebrushing to remove rust scale and loose rust. The *specially-processed fish oil vehicle* in the primer penetrates rust to bare metal—driving out air and moisture. Easy as that to Stop Rust—and save time, money, and metal.

For *lasting beauty* – follow up with a Rust-Oleum finish coating in the color of your choice – from grays, greens, blacks, and aluminums to yellows, blues, whites, or browns – or from the many popular pastel shades.

That is the Rust-Oleum *System* of primer and finish coat for maximum over-the-years protection. A system that is measured by the money you save. Specify Rust-Oleum for maintenance, new construction, and re-modeling. Your Rust-Oleum Industrial Distributor maintains complete stocks for prompt delivery . . . he will be happy to consult with you on your coating problems.

What is your coating problem? What **color** do you need? Get lasting beauty in the color of your choice. Mail coupon for color charts.

**SEND FOR FREE TEST SAMPLE! ATTACH TO YOUR LETTERHEAD!**

Rust-Oleum Corporation
2981 Oakton Street, Evanston, Illinois

**Please send me the following at no cost or obligation:**

- ☐ Free test sample of Rust-Oleum 769 Damp-Proof Red Primer for rusted metal surfaces.
- ☐ Complete literature with applications and color charts.
- ☐ Information on matching special colors.
- ☐ Thirty-page report on Rust-Oleum fish oil penetration.

SEE OUR CATALOG IN SWEET'S
OR WRITE FOR COPY

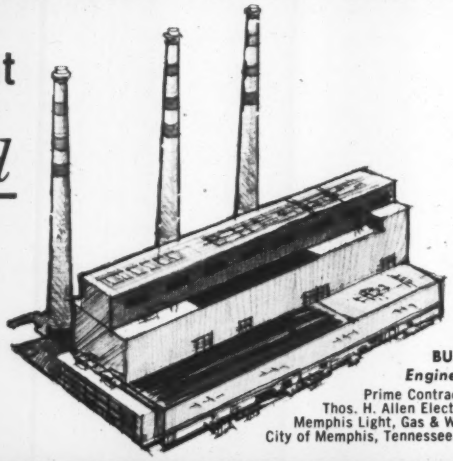
**A matter of excellence.**
**Distinctive as your own fingerprint.**

# 9 PACIFIC BOILER FEED PUMPS

**performance-tested in our plant**

*Performance-proved*

*in Memphis...*



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***Engineers and Constructors***
Prime Contractors for the
Thos. H. Allen Electric Generating Station,
Memphis Light, Gas & Water Division,
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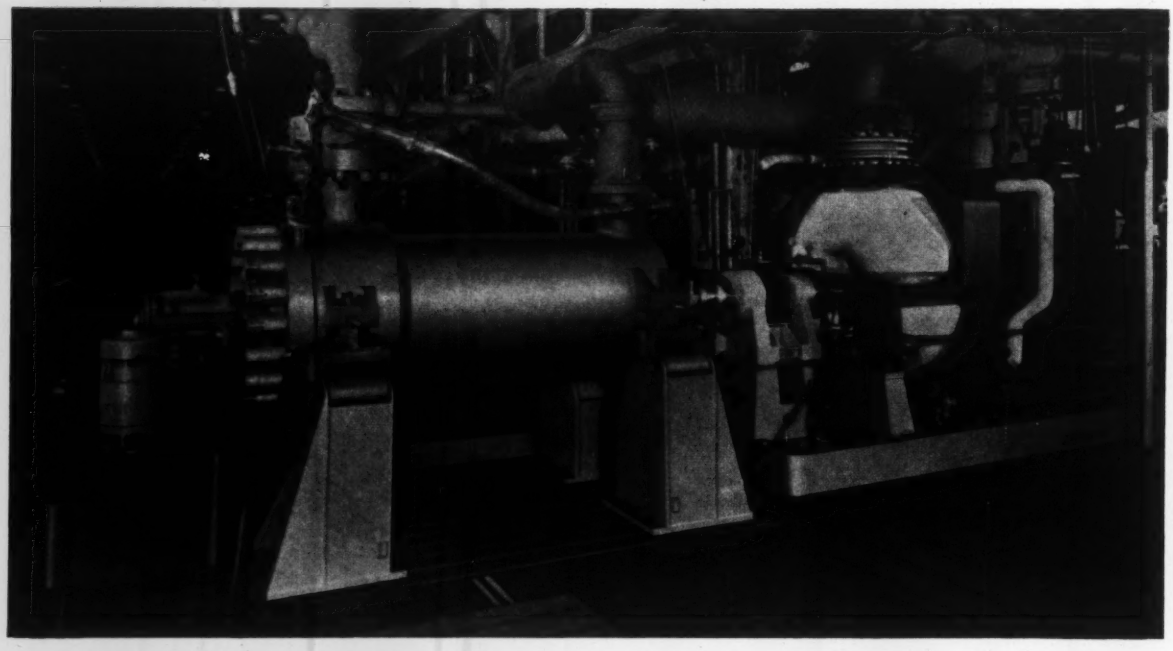


***One of nine City of Memphis 12-stage Pacific boiler feed pumps on performance test in Pacific's especially engineered testing laboratories. All nine pumps were completely tested at Pacific — are now on the line in the Memphis plant...***

**INSPECTION** – Each and every part of PACIFIC Boiler Feed Pumps is inspected and checked prior to assembly. The finest precision gauges are used to check the accuracy of each part, to insure the proper fit during assembly as well as the proper fit when replacement parts are installed in the field.

**HYDROSTATIC TESTS** – Each part subject to internal pressure, whether forged or cast, is hydrostatic tested. This includes such parts as the case, heads, jacketed packing housings and bearing housings.

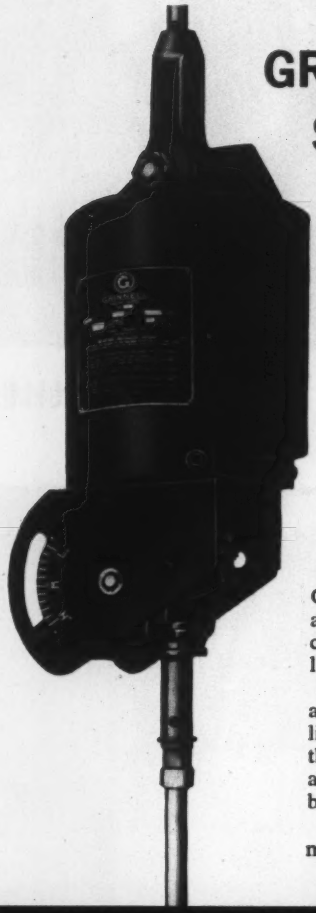
**PERFORMANCE TEST** – PACIFIC's test laboratories are equipped with calibrated motors and instruments; a variable-speed steam turbine coupled to a torque meter. Closed tanks, vacuum pumps and all other equipment necessary accurately establish the complete performance characteristics of each pump. Test procedure for multi-stage pumps also includes a check of axial thrust.

PACIFIC®

**PACIFIC PUMPS**
*Inc... A Division of Dresser Industries, Inc.*
HUNTINGTON PARK, CALIFORNIA
*Offices in all Principal Cities*

BF-29

# GRINNELL CONSTANT SUPPORTS...



## 2 BASIC DESIGNS... 11 DIFFERENT METHODS OF ATTACHMENT

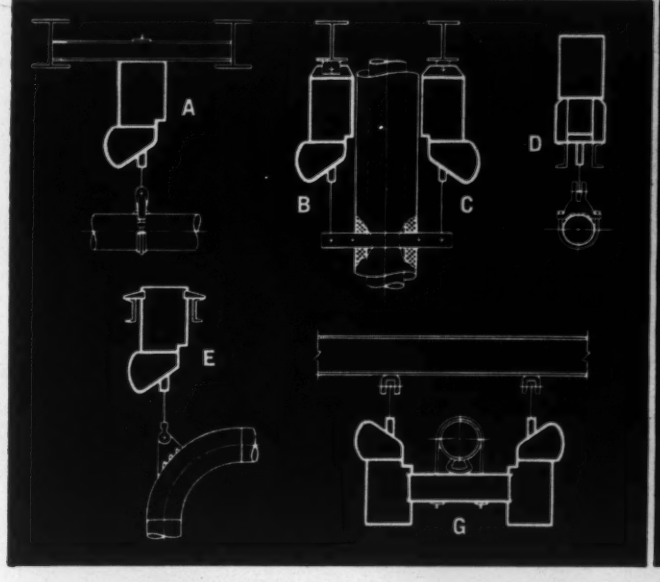
Grinnell Constant Supports are available in a range of sizes to provide capacities for loads from 27 lbs. to 57,500 lbs., with travels up to 16 inches.

Both vertical and horizontal hangers are designed to operate in extremely limited space. In the selection of types, there is a choice of 11 methods of attachment to structures—either above, between, or below supporting steel.

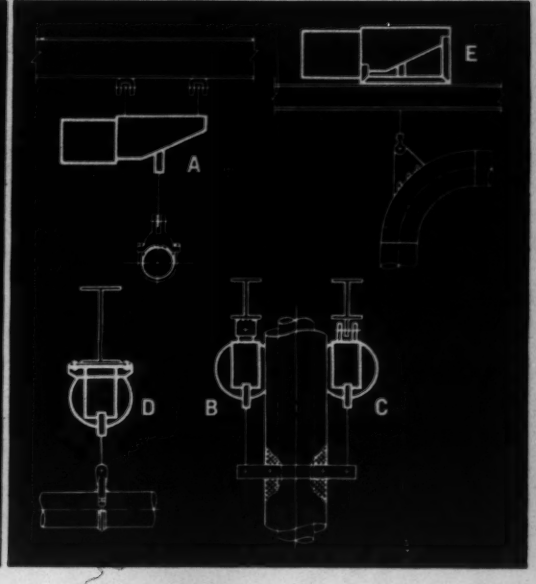
Grinnell Constant Supports provide mathematically perfect load support throughout all positions of travel . . . also a full 70 percentage points of adjustability is built into them. No less than 10% of this adjustability is allowed either side of calibration for plus or minus change in load. Field readjustments are easily made by turning a single load adjustment bolt.

Call on Grinnell's Pipe Suspension Department for help with your pipe suspension problems. Grinnell Company, Providence 1, Rhode Island.

FOR VERTICAL ATTACHMENT

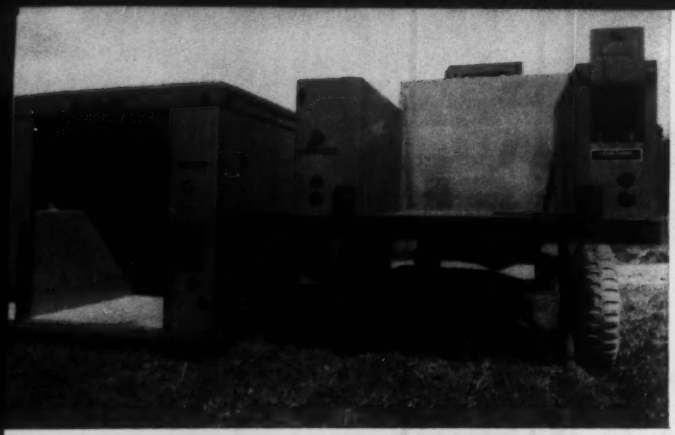



FOR HORIZONTAL ATTACHMENT




GRINNELL

AMERICA'S No. 1 SUPPLIER OF PIPE HANGERS AND SUPPORTS



The Thompson Level-Loder raises and lowers to any height from curb side to 4½ feet. Hydraulic cylinders lift the body up and down in a vertical guide mounted on the truck cab. Thompson Trailer Corp., Pikesville, Maryland, a subsidiary of General American Transportation Corp., Chicago, introduced the new design.

## It tilts . .

. . it leans . . . . . it hunches up and down

# Unique truck built lighter, stronger with USS COR-TEN Steel

Here's a truck body that acts like an elevator. With front wheel drive, it has no rear axle or drive shaft. Hydraulic cylinders tilt it forward, backward, sideways, and raise it up and down to any height from curb level to 4½ feet. This cuts loading time as much as 75% and makes unloading up to five times faster.

Because the main stress of the lift is concentrated at the wheel box housings, they have to be as strong as possible. And because the truck body is lifted along with the payload, the body has to be as light as possible. The entire body, including the wheel housings, was built with USS COR-TEN High-Strength Low-Alloy Steel because this grade meets the demands of both lightness and high strength. COR-TEN Steel's 50% higher yield point means it can be used in thinner and lighter gages, reducing weight as much as ⅓ with no sacrifice in strength. And it has high resistance to abrasion, atmospheric corrosion, impact and fatigue.

U. S. Steel produces three brands of High Strength Steel—COR-TEN, TRI-TEN, and MAN-TEN. Each has characteristics that make it ideal for special design applications. For complete information about these "steels that do more", write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. *USS, COR-TEN, TRI-TEN and MAN-TEN are registered trademarks*

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
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**United States Steel**

**One order, one source**
... every fastener need!

# Some things need to be different...

Sound connections are of utmost importance to every project, especially today as requirements become increasingly critical. Many times the unusual is the economical answer. Making the unusual is an important part of our service. And because of our complete facilities and design engineering experience, we usually come up with complete answers.

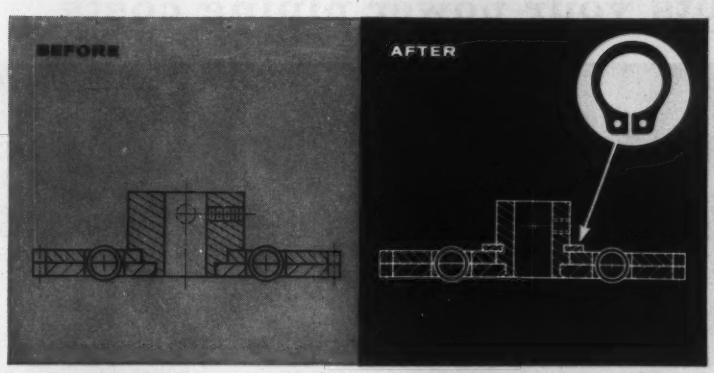
For operating dependability and efficiency, we might suggest a slight modification of design or material of the part in use. Then again, one of our many standards may better suit your needs. Either way, if you have a particular connection problem—one requiring a low-cost solution, let us see what we can do to help. The services of our specialists are readily available through your Screw and Bolt representative. Contact him today or write us direct. Others do.

VMA 6732

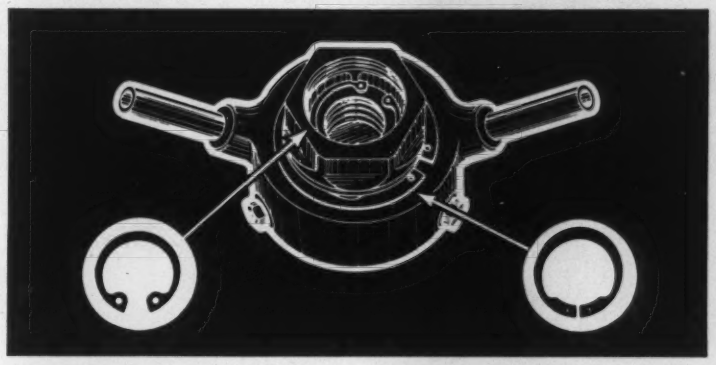
**SCREW AND BOLT CORPORATION OF AMERICA**

*Formerly Pittsburgh Screw and Bolt Corporation* • P. O. Box 1708 Pittsburgh 30, Pennsylvania

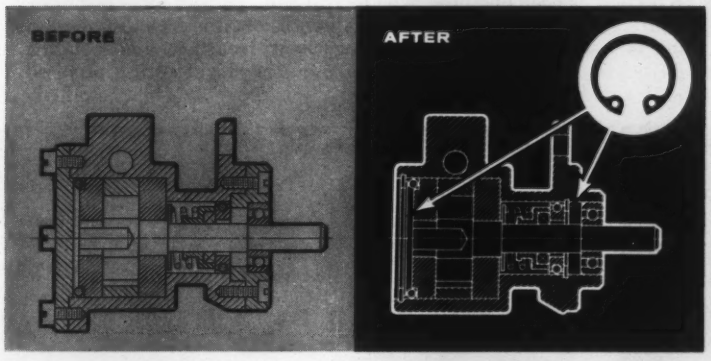
AMERICA'S MOST COMPLETE LINE OF INDUSTRIAL FASTENERS




**Gear assembly improved.** A Waldes Truarc Series 5100 retaining ring in this anti-backlash gear assembly eliminates machining and staking operations, reduces hub size, and allows easy disassembly, after gears are cut as a unit, for faster, better deburring. **Typical savings: $350.00 per 1000 units.**



**Threaded retainers eliminated.** In this self-sealing coupling, costly internal and external threaded retainers were eliminated by easy-to-apply internal (Series 5000) and external (Series 5108) Truarc retaining rings. **Savings per unit amounted to $4.02.**




**End-cover design simplified.** In this general-purpose pump, two Waldes Truarc, Series 5000, internal retaining rings make possible the elimination of two cover-plate castings (plus machining) and eight screws (plus drilling and tapping). Weight and dimensions are reduced and assembly and disassembly are greatly facilitated. **Typical cost savings: $1.48 per unit.**

©1959 WALDES KOHINOOR, INC.

WALDES
TRUARC®
RETAINING RINGS
Waldes Kohinoor Inc., Long Island City 1, N. Y.

# Designing for axial assembly with Truarc retaining rings

## eliminates parts, machining, speeds assembly, simplifies maintenance

The proper application of retaining rings on or in axial assemblies can often effect startling simplifications and economies in design when compared to corresponding designs with conventional fastening devices. A few typical examples, using basic types of retaining rings, are shown in the accompanying drawings.

Threading, tapping, drilling, facing and other costly, time-consuming operations can be eliminated. Retaining rings are already in wide use in a tremendous variety of equipment ranging from household products to high-precision military gear designed for use under the most severe environmental conditions. They are quickly and simply installed in easily cut grooves which can often be machined simultaneously with other operations. The rings can frequently replace bulkier, more costly fastening devices—such as nuts, screws, studs, threaded sleeves and retainers, cotter pins, set collars, rivets and machined shoulders.

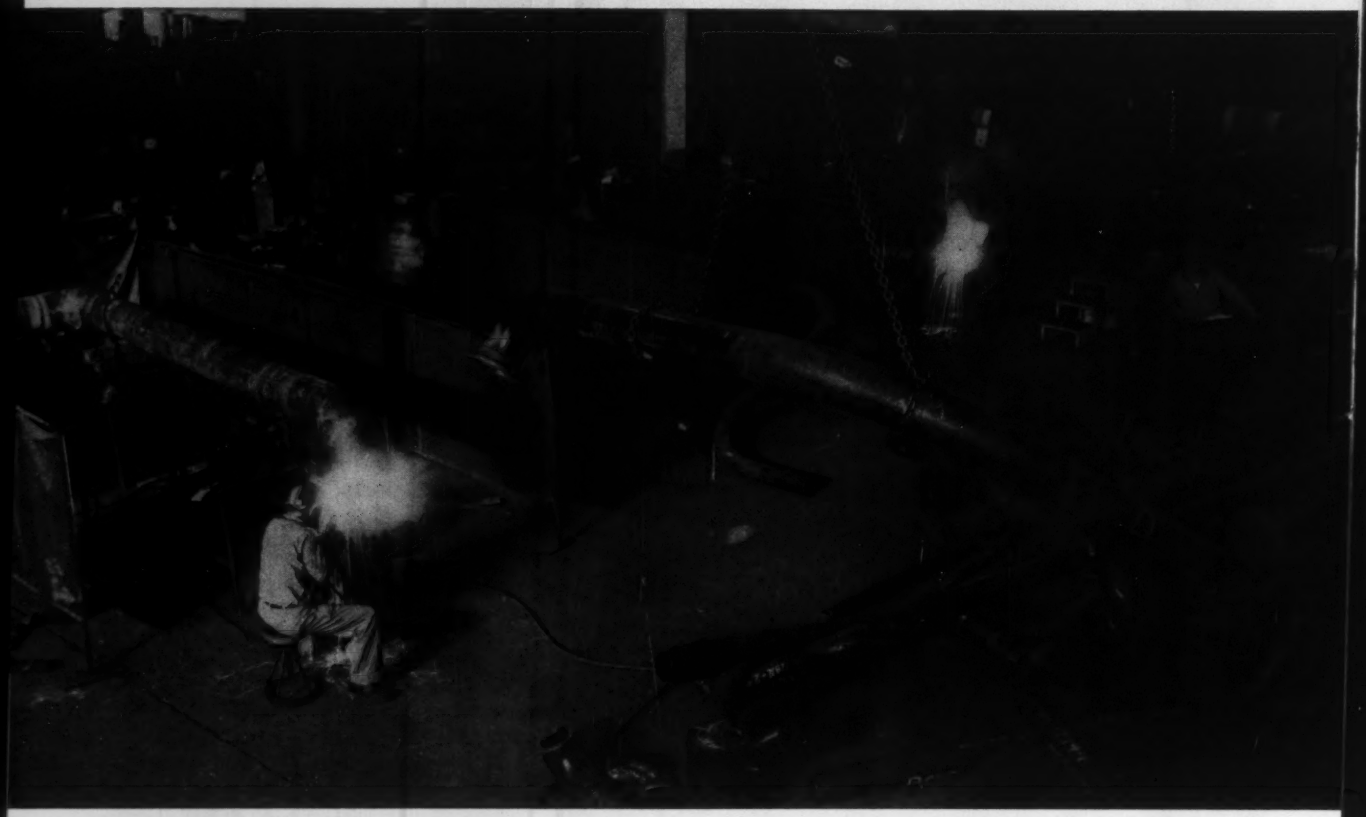
What's more, rings frequently make practical designs which could be achieved with no other known fastening device.

Although the ring types shown here are basic, Truarc retaining rings come in 50 functionally different types, as many as 97 different sizes within a type, 6 metal specifications and 13 finishes. You'll find detailed descriptions of Truarc retaining rings and assembly tools, plus more than 70 typical applications in the new 24-page catalogue RR10-58. Write for your copy today.

And remember, Waldes engineers are always ready to help you solve your application problems—whether it involves one of the standard Truarc rings or a "special" to fit your particular requirements. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y. 9.1

TRUARC RETAINING RINGS...THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

# How Blaw-Knox cuts your power piping costs



**121,000 square feet of space at your service.** Power piping facilities at Pittsburgh include 56,000 square feet of plant area and an additional 65,000 square feet for exterior storage. An additional new plant is located on a 15-acre site in Jackson, Mississippi.

Your job is under the personal supervision of an experienced engineer, who follows your project from beginning to end. Your piping is handled with the most modern equipment for welding, heat treating, and bending. Fabricating techniques, proven by rigid testing, are used.

**New product development.** Blaw-Knox pioneered the enclosed type of functional spring hanger as part of their complete line of hangers for supporting any piping system. Here a group of hangers individually designed for a project is factory checked to assure fast field erection.

**Stress calculation cut from months to a day . . .** with pace-setting engineering. An exclusive Blaw-Knox method uses an electronic computer for automatic computation with no limitation on the complexity of system. Full accuracy, with tremendous savings in time and cost. Write for details.

BLAW-KNOX

**BLAW-KNOX COMPANY**
*Power Piping Division*
*829 Beaver Avenue, Pittsburgh 33, Pennsylvania*

# Some Ideas

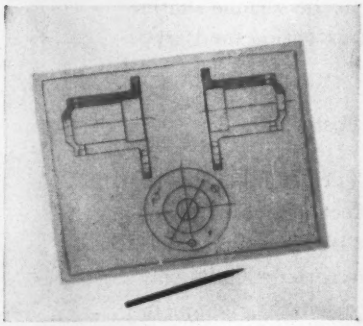
for your file of practical information on drafting and reproduction from

**KEUFFEL & ESSER CO.**

A year of relentless testing has produced a small library of interesting facts about HERCULENE (T.M.) Drafting Film. What follows is a consensus of drafting-room experience with HERCULENE—by K&E and its customers—with some up-to-date recommendations for using it. Take the matter of...

### Shiny Back vs. Pencil Back

A basic question is: do you need a double-surfaced drafting film? We make HERCULENE Drafting Film both ways, of course —with a single surface (shiny back) and double surface (pencil back). It's our recommendation that you use pencil back HERCULENE only if it's your practice to make basic drawings on one side, changes on the other. For most other uses, shiny back is preferable. (At first, the double-surface film was chosen by many drafting rooms because it lay flatter on the board than shiny back. This is no longer true. K&E research labs have come up with a fully effective anti-curl treatment.) Especially in filing, shiny back HERCULENE presents fewer problems. The clean non-abrasive back won't smudge the face of the sheet underneath, even in a heavy stack of tracings. If you'd like to compare a few sheets, please let us know.



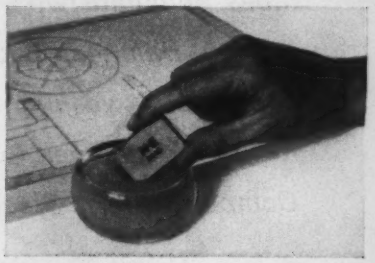
Note sharp clear lines made by Duralar pencil on HERCULENE Drafting Film.

### Plastic Pencils and the HERCULENE Surface

Not just a handy catch-phrase, when K&E puts its exclusive "engineered surface" on a drafting material, the result is an exact, uniform tooth for sharp pencil drawing, inking and typing. With HERCULENE Drafting Film, however, an entirely new type of plastic (non-graphite) pencil yields especially good results. Quite a few of our customers have reported favorably on the well-known Staedtler "Duralar" brand. Duralar pencils come in five hardnesses, are non-smudging and have generally good covering power, sharpness and erasability. After about 20 prints, the Duralar lines show up consistently better than those made by a regular pencil, since graphite lines tend to lose density.

### Wet That Eraser!

The erasing qualities of HERCULENE Drafting Film are excellent, but (as with the pencils) we've discovered it's a new type of vinyl eraser that gives the best results. Examples of these non-rubber type erasers are the Richard Best "TAD" and the Eberhard Faber "RACE KLEEN" – both available from your K&E dealer. With vinyl erasers, pencil lines whisk off. Even stubborn ink and typing can be removed easily, with no damage to the surface. Here's a tip on how to do this:

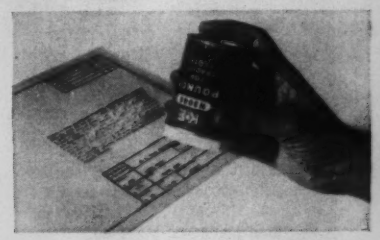


Moisten the eraser slightly. It becomes no more abrasive, but a lot more "erasive." Moistening is a must when removing Duralar lines or typing after exposure to heat. (Incidentally, don't use electric erasing machines, steel erasers or typewriter erasers.) When erasing large areas, certain chemical eradicators work fine too. Our suggestion: use Vythene or a very light application of a denatured alcohol such as Solox, both of which can be applied with a cotton swab or clean cloth.

### The Cleaner the Better

HERCULENE Drafting Film was designed for ink work, and its ink take is unexcelled. But like all films, its non-absorbency makes a few preparations advisable. The surface should be cleaned thoroughly before inking. Quickest and most effective way to do this is with the ABC Draftsman's Dry-Clean pad, which will remove finger marks and "traffic film" simply by rubbing the pad over the surface. Pouncing will also work well. A damp cloth is all right for general cleaning, but does not do the best job of preparing the surface for ink.

Inking over graphite pencil lines comes out best when done over light lines, drawn with a harder grade of pencil. A good way to remove excess graphite is to go over the drawing with an ABC pad. Inks vary in their usefulness on HERCULENE. We've tested several, and you're welcome to these results as well, on request.



### After Typing, Please Pounce

Typed impressions on HERCULENE Drafting Film are crisp and sharp, but may take a while to dry because the film's surface doesn't "swallow" ink readily. A light pouncing right after typing will dry the ink and fix the lines – giving you uniform permanent contrast.

A new typewriter ribbon will produce the best impressions. At K&E we've tested a healthy variety of ribbons and we'd be pleased to send you the results on request.

### Outstanding Advantages Proved in Tests

We're pleasantly amazed at the short time it took for HERCULENE Drafting Film to become an accepted "staple" – along with ALBANENE® Tracing Paper and PHOENIX® Tracing Cloth. Actually, it's a rare drafting room by now that has *not* tested HERCULENE during its first year on the market. The findings: All properties considered, HERCULENE stands up better than any other drafting film. It has great resistance to heat, aging and abuse. Its exclusive "engineered surface" plus its tough, durable Mylar® base provide superior pencil and ink take, fine erasability, remarkable dimensional stability...a combination we're proud to call unbeatable!

**The K&E dealer near you has HERCULENE now. Stop in and see him.**

**KEUFFEL & ESSER CO., Dept. ME-6, Hoboken, N. J.**

Please send further information about HERCULENE Drafting Film. I'd like samples too.

Name & Title _____

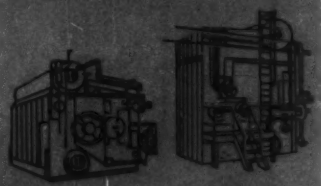
Company & Address _____

_____

2001

Power Plant Products
HEAT ENGINEERED BY FW

CONDENSERS and HEATERS—Condensers custom designed for individual plant requirements. All-welded high and low pressure feedwater heaters.



PACKAGED and FIELD-ERECTED BOILERS—Compact, economical, standardized units in capacities from 10,000 to 450,000 lb/hr oil, gas or pulverized coal fired.

LARGE STEAM GENERATORS—Designed to meet all requirements for Central Station or Industrial power plants, in single- or twin-furnace designs, with or without reheat or dual circulation.

COOLING TOWERS—Induced draft counter flow towers of all-redwood construction for maximum dependability and long service.

NUCLEAR COMPONENTS—Heat exchangers, steam generators, pressurizers, reactor vessels, separately-fired superheaters for stationary and marine power plants.

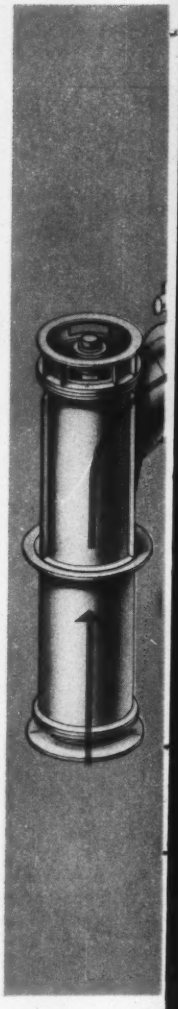
PULVERIZED FUEL SYSTEMS—Completely engineered systems utilizing FW ball mill or MB planetary roll and table pulverizers.

# HEAT ENGINEERING

## SIMPLIFIES LAYOUT and

## WITH NEW SINGLE-PASS,

*Compact shells use economical short tubes, eliminate two waterboxes, simplify valving. Balanced back pressure and built-in backwashing system offer further advantages for Alabama Power Company's Barry Steam Plant, Unit No. 3.*



**Problem:** Alabama Power Company and Southern Services, Inc., Engineers, specified that the dual exhausts of the 225,000 kw turbine be handled with condenser tubes at right angles to the turbine shafts —in the tight confines of a plant extension for Barry Steam Plant, Unit No. 3.

**Solution:** Heat Engineering by Foster Wheeler

By application of the established principles of Foster Wheeler condenser design, a most economical arrangement for a twin bottom-exhaust turbo-generator set with tubes at right angles to the turbine shafts was provided. It features short tube lengths, complete backwashing and a minimum number of waterboxes for a twin-shell design.

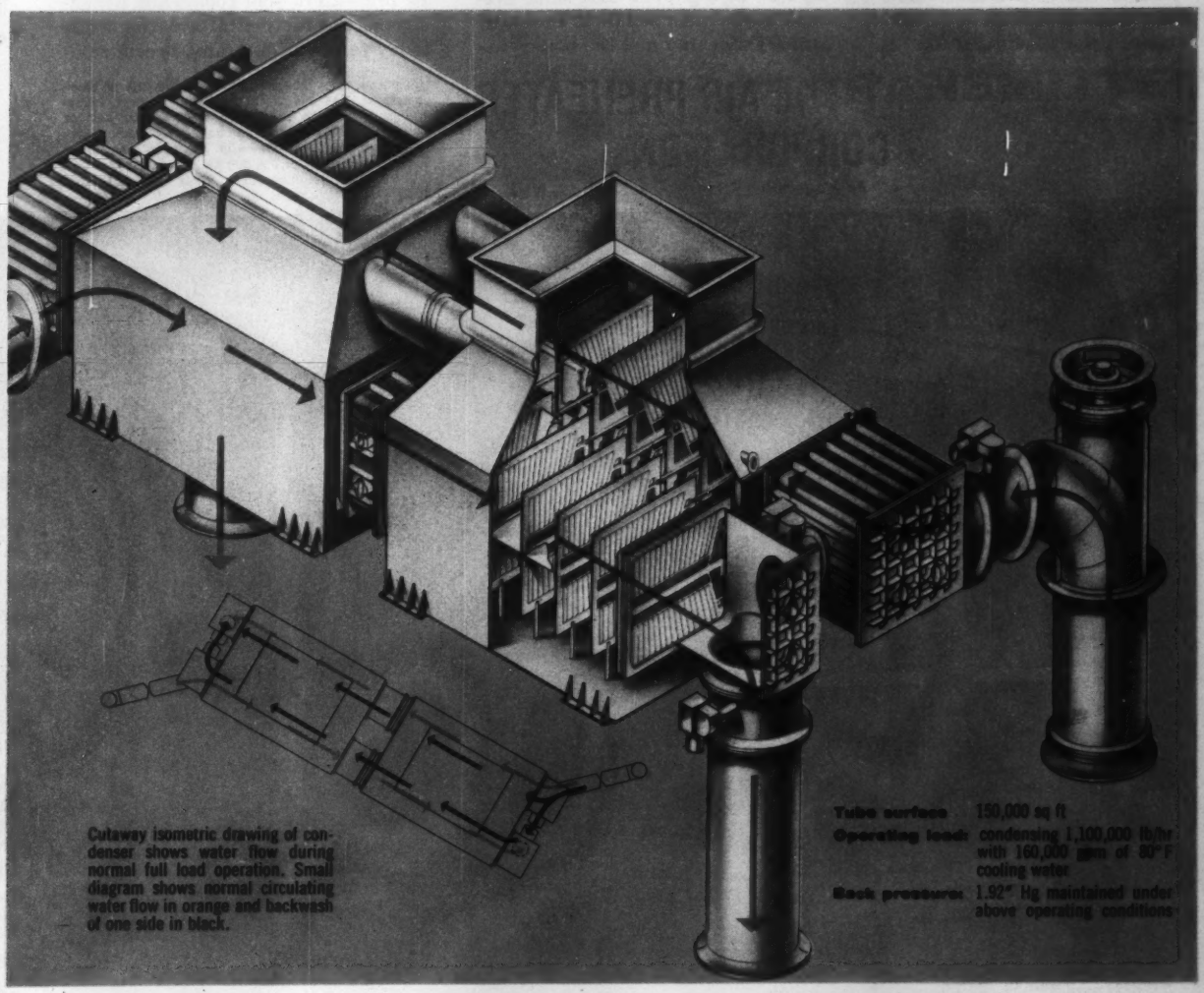
Backwashing of the tube sheets is obtained with only six valves, two of which are the normal circulating pump shut-off valves. This valving arrangement also allows the complete condenser to be operated at light loads with only one circulating pump.

In design advances such as this, you see Heat Engineering at work. This is the concept you can expect—combining new and original ideas with proved engineering principles—when Foster Wheeler serves you. *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.*

# BY FOSTER WHEELER

# REDUCES CONDENSER COSTS

# COUNTER-FLOW DESIGN



Cutaway isometric drawing of condenser shows water flow during normal full load operation. Small diagram shows normal circulating water flow in orange and backwash of one side in black.

**Tube surface** 150,000 sq ft

**Operating load:** condensing 1,100,000 lb/hr with 160,000 gpm of 80°F cooling water

**Back pressure:** 1.92" Hg maintained under above operating conditions

## FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

# 6 Ljungstroms® go to work for the city of Memphis ...and so does lifetime Air Preheater service

The City of Memphis Light, Gas and Water Division has just installed three boilers served by six Ljungstrom preheaters. Why Ljungstrom preheaters? One reason is service. Air Preheater engineers don't just wait for a call. They regularly inspect and help maintain Ljungstroms *through the life of each unit.*

What's more, Air Preheater provides rapid *factory* service in an emergency. Here's an example. A customer phoned on a Friday morning for a replacement trunnion—a major integral part of the preheaters. His Ljungstrom was 17 years old, which meant that a new trunnion had to be custom made to match his older-style. He was located 500 miles away. And he needed his boiler back on the line by Sunday.

Air Preheater went to work. Special trucking was arranged. The job was done *and shipped* that same evening. The customer had the trunnion by Saturday morning and the boiler was back on the line by Saturday evening!

Fast response to emergencies and regular inspection of Ljungstrom installations are two of the many advantages Air Preheater provides its customers. Another is expert knowledge of boiler and preheater problems —and how to lick them—gained from over 35 years of experience. Perhaps these reasons explain why 9 out of 10 preheaters sold today are Ljungstroms. For further information write today for free illustrated brochure.

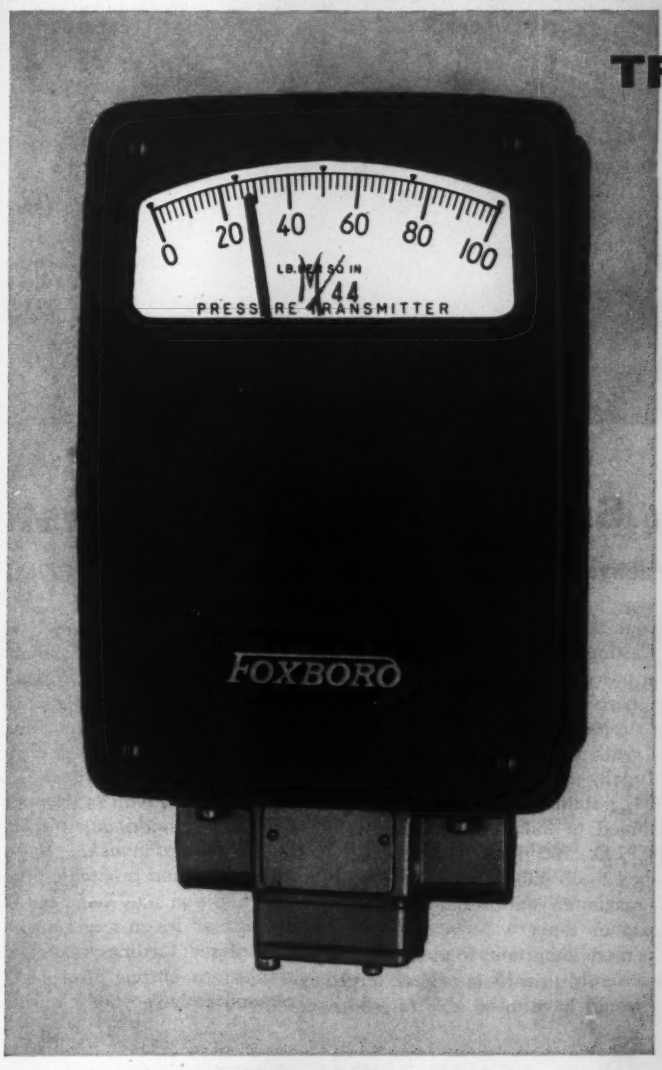
**THE AIR PREHEATER CORPORATION**

*60 East 42nd Street, New York 17, N. Y.*

Ljungstrom rotor being installed for the City of Memphis Light, Gas and Water Division. Six such Ljungstroms—each with 201,400 sq ft of heating surface—will serve three boilers. The boilers will each evaporate 2,000,000 lbs of steam/hr and have a combined nameplate capacity of 750,000 kw. A fourth boiler unit is now under consideration. Burns and Roe, Inc. designed and supervised construction.

# read pressure up to 20 ft. away!

## on the FOXBORO M/44 INDICATING PRESSURE TRANSMITTER




You can check pressure readings at a glance on the Foxboro Pneumatic Indicating Pressure Transmitter. Its open-face, horizontal, 4-inch indicator scale and eye-catching red pointer are clearly visible as far away as 20 feet.

But high readability is just part of the story. Actually, this instrument was engineered from the ground up. Makeshift arrangements have been eliminated, hung-on gauges are gone. Everything is included in one compact (5¾" x 8⅛"), ready-to-install instrument that weighs only eight pounds.

Because the indicating pointer is direct-connected to element and transmitter, calibration is easy . . . and you can re-zero the transmitter externally. All M/44 components are standard, performance-proved Foxboro parts. This makes it easier to stock and service.

A wide selection of interchangeable Foxboro pressure measuring elements gives the M/44 range limits of 0-30" water to 0-6000 psi. Elevated ranges are available, too.

Write for complete details. The Foxboro Company, 966 Neponset Ave., Foxboro, Mass.

**FOXBORO** REG. U.S. PAT. OFF. **INSTRUMENTATION FOR INDUSTRY**

This is one of the five Sandusky Centrifugal Castings supplied to Fluor for use in their "liquid air" converter cartridges. Picture shows part of the 7000 components housed in each of the 16½-foot cylinders machined by Sandusky to allow only .010" clearance limit between assembly and cylinder wall.

# SOLVED by Sandusky Centrifugal Castings:

## This difficult precision-cost-delivery problem for the FLUOR PRODUCTS COMPANY.

**Sandusky Quality Centrifugal Castings**

**Types:** Rolls, Sleeves, Rings, Bearings, Bushings, Liners, Bands, Drums, Cylinders, Tubes, Shells, Retorts, Pressure Vessels, Pressure Piping

**Sizes:** From 7" to 54" O.D.—Lengths up to 33 feet

**Materials:** Stainless, Carbon and Low-Alloy Steels; full range of Copper-Base and Nickel-Base Alloys

Dimensional stability of Sandusky Centrifugal Castings enabled the Fluor Products Company to fit more than 7,000 precision parts into each of 5 identical cylinders supplied by Sandusky for use as ammonia synthesis converter cartridges.

Centrifugally cast of a modified CF8 (Type 304L) stainless steel, each cylinder was machined to finish dimensions 27¾" O.D., 26⅝" I.D., 199" long. The bore, surface finished to 35 micro inches, was held to .005" maximum out-of-roundness and .008" maximum taper.

What is more important, to meet Fluor's difficult assembly problems these large cylinders would have to be able to retain these carefully machined dimensions.

*"The Fluor Products Company Engineers selected Sandusky Centrifugal Castings because of the stringent specifications, critical delivery requirements and competitive cost of this project. This was the first experience with such centrifugally cast products by the Fluor Products Company; and, the Sandusky Foundry and Machine Company people assisted in making this an extremely satisfactory and profitable project."*

While you may have entirely different cylindrical design requirements, Sandusky Centrifugal Castings may well provide a similar cost-cutting answer. We would be pleased to have your inquiries.

**SANDUSKY** CENTRIFUGAL CASTINGS
**FOUNDRY & MACHINE CO.**

SANDUSKY, OHIO Stainless, Carbon, Low Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

# SAFETY IN THE RIGHT PERSPECTIVE

## with Flexitallic Spiral-Wound Gaskets

In this enlarged sectional view, you can see the Spiral-Wound Gasket construction originated by Flexitallic in 1912. And you can see Flexitallic Blue, the blue dye in the Canadian asbestos filler, which is the mark of an engineered Flexitallic Gasket.

Flexitallic means sealing at its safest. You get performance you can depend on throughout all pressure/temperature ratings, because the compression characteristics of the gasket are always related to the pressure/temperature ratings of the flanges with which they are assembled.

When fluids are confined in a critical pressure/temperature range . . . when flanged joints are subject to thermal and mechanical shock, vibration, weaving, and other joint stresses . . . engineers demand the maximum in gasket performance.

That's why they specify Flexitallic Spiral-Wound Gaskets.

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8th & Bailey Sts. Camden 2, N.J.

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

* Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.

# Save hours of searching through equipment catalogs... call in AMERICAN-Standard!

Your American-Standard* Industrial Division representative can usually put his finger on what you're looking for in a hurry. He knows his products and what they can (and can't) do.

Your local Industrial Division man is a seasoned graduate engineer – one who's logged a lot of experience in many fields. He speaks your language. And he's backed by the combined American Blower, Ross, and Kewanee product lines. You talk to one man about air conditioning and refrigeration, heating, ventilation, heat transfer, dust collection, and fluid drives. Gain one-source responsibility for quality and performance in equipment that is designed, engineered, and manufactured to work together.

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AMERICAN-Standard

INDUSTRIAL DIVISION

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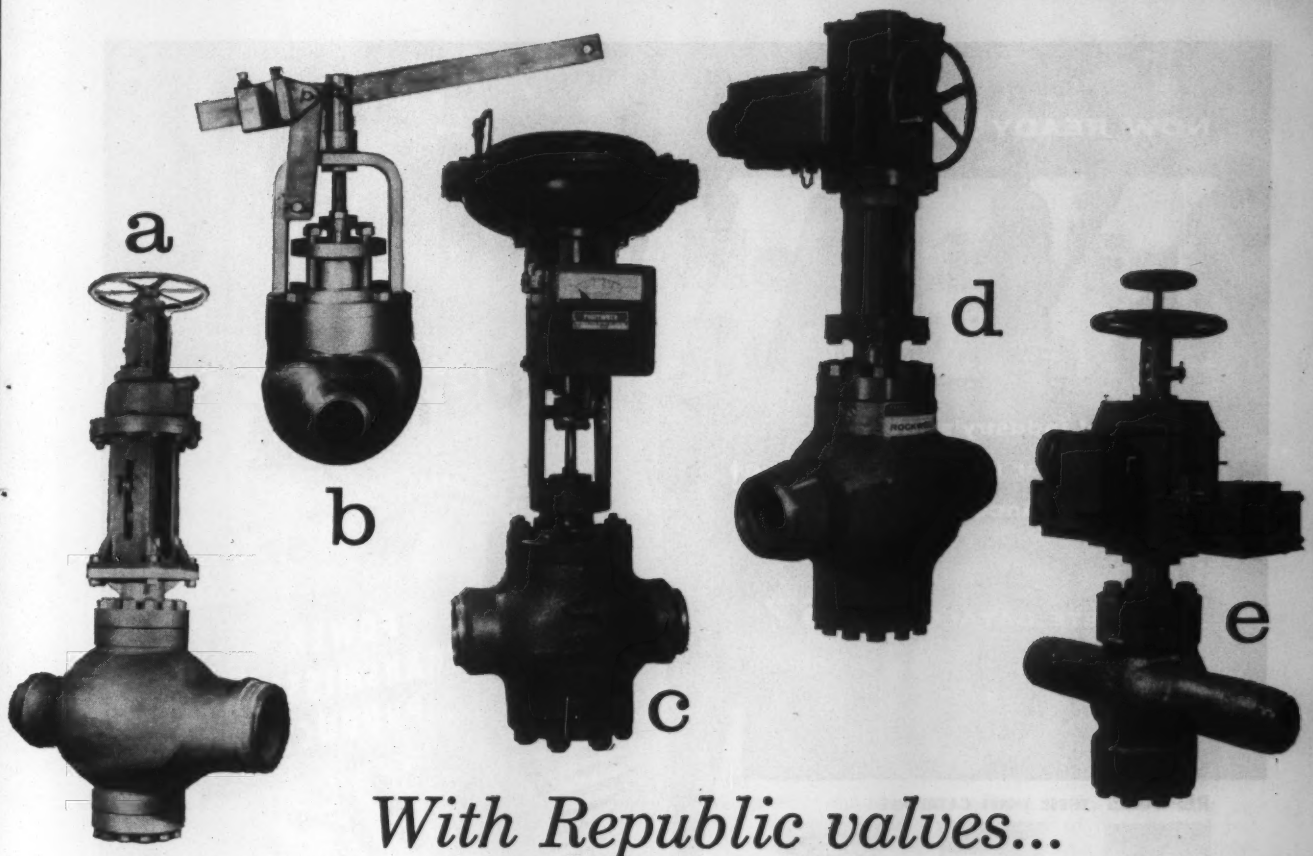


*With Republic valves...*

# You get longer life, less maintenance

For over 35 years Republic valve developments have paced the changing demands for more sturdy valves by the most progressive utilities and industries. For such services as pump recirculation control, feedwater regulation, steam pressure reducing and high pressure water control, Republic valves have established a reputation for durability, long life and trouble-free performance.

**Superior valve design**—Republic research into the causes of valve noise and vibration, and also the wear resisting and galling properties of materials has resulted in a modern line of Republic valves of advanced design. Republic valve contours are designed to produce not only the desired regulating characteristics but also to reduce erosion damage and noise as well. Extra large guide bushings, extra deep stuffing boxes, solid plug inner valve construction, plus precise manufacture and long-life materials make Republic regulating valves perform better, last longer, with less maintenance.

**Wide selection of valves and features**—Rockwell-built Republic regulating valves shown on this page are representative of the complete Republic line:

- **a. Cylinder operated valve**
- **b. Lever operated valve**
- **c. Diaphragm operated valve**
- **d. Motor operated valve**
- **e. Toggle head operated valve**
- **f. Diaphragm operated angle valve**

And, for many special applications, such Republic accessories as pneumatic and electric valve positioners for hysteresis-free control, and a complete line of controllers are available.

Whatever your regulating valve problem, let Republic engineers put their years of application experience to work for you. For additional information, see your Republic representative, or write to Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Illinois.

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NOW READY . . . the

# NEW

edition of industry's favorite guidebook for transmission design and maintenance economy.

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**REPLACES THESE THREE CATALOGS**



No. 56 No. SC-3 No. OP-1

Lists NEW Gears and gear information. NEW expanded line of Sprockets and Chain for any drive ¼" to 2" pitch. NEW OPTIMOUNT helical geared Speed Reducers, shaft mounted and base mounted. NEW types and sizes in every product line. 664 pages, with 58 pages of improved selection charts and engineering information to help you simplify transmission planning. Boston Gear Works, 66 Hayward St., Quincy 71, Mass.

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For nearest Distributor LOOK UNDER "GEARS" in the 'Yellow Pages'

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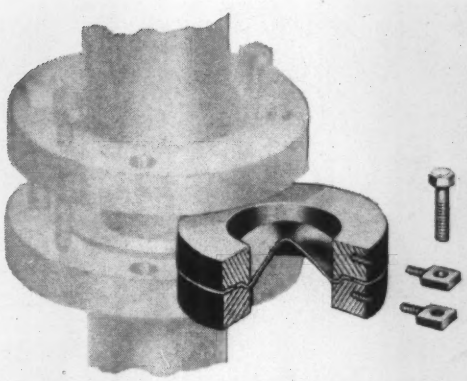


# New Life For Relief Valves

## How Corrosion And Plugging Can Be Eliminated

**Pressurized corrosives and coagulatives have always presented problems in the maintenance of relief valves. In one case deterioration of valve sealing surfaces is seemingly inevitable...in the other, valve aperture becomes restricted or completely clogged.**

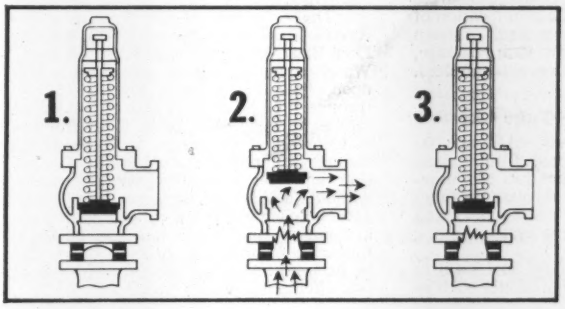
### *Positive Barrier Alone Won't Do The Job*

The only sure way known to prevent these difficulties is to introduce a barrier between the pressurized product and the working parts of the relief valve. Of course just any sort of barrier isn't suitable. The effectiveness of valve operation would suffer. Therefore, the barrier must be removed at the precise moment that pressure reaches that point at which the valve must open.

### *This Special Barrier Does It*

By installing a BS&B Quik-Sert Safety Head under the valve full protection of valve parts is provided. As long as normal operating pressure is maintained the rupture disc within the Safety Head remains intact... the valve is isolated from any unwanted influence present (Illustration #1).

When a predetermined pressure level is reached the barrier-disc ruptures instantly (Illustration #2). Pressure opens the valve, is bled back to normal, at which point the valve closes (Illustration #3). Processing or product transfer is continued temporarily without interruption.




### *Replacement Is Fast, Inexpensive*

Later at any convenient time, when the system is idle, the valve can be cleaned and the Quik-Sert Safety Head replaced. A two-fold reduction in overall costs is achieved through the use of a Quik-Sert Safety Head for valve protection... (1.) Service life of the valve is multiplied, thereby saving the cost of replacement many times, (2.) Even in the event of abnormal overpressure, operations can continue without stoppage until normal completion is reached.

### *Change-Of-Operation Problems Reduced*

Another advantage is provided by BS&B Quik-Sert Safety Head protection for relief valves. In the event unexpected changes are necessary in processing or there is a change in the character of the product involved, you will not need to change to a different safety or relief valve. The Quik-Sert previously in service can be removed and an alternate unit of the proper specifications installed beneath the same relief valve with a minimum of effort.

### *Valve Protection Not Only Use*

Of course, the use of BS&B Safety Heads is not limited to application under relief and safety valves. Overpressure protection can be provided in any situation where ignition or exothermic reaction during a given process causes an abnormal pressure rise in seconds or milliseconds.

The uses and designs of Safety Heads are undergoing continuous expansion. Presently they are proving their value in such widely diversified fields as Food and Chemical Processing, Aircraft and Missile Propulsion, Oil and Gas Production and Processing, Air Conditioning and Refrigeration, Electrical Power Generation and many others.

### *Do You Have A Unique Pressure Problem?*

New and unusual pressure relief requirements involving corrosives, elevated or sub-zero temperatures, pulsating pressures, alternate pressure and vacuum, pressure cycling, or even low-to-high-pressure shock are constantly being solved by the BS&B Safety Head.

If you need a device for the protection of relief or safety valves... if you need overpressure protection not requiring the use of valves or have a pressure transfer requirement calling for a device that will provide instantaneous pressure release, be sure to consider the BS&B Safety Head. It may very well be your answer. Contact your nearest BS&B Sales office or agent, or the Safety Head Division Headquarters in Kansas City.

**BLACK, SIVALLS & BRYSON, INC., Safety Head Division, Dept. 2-FQ6**
**7500 E. 12th Street, Kansas City 26, Missouri**

## How C. H. Wheeler condenser design provides optimum deaeration and REDUCES STATION MAINTENANCE

***An informative advertisement from one of the nation's most experienced condenser manufacturers***

The problem of power plant steam system maintenance involves many things including cleaning the water and steam sides of condenser tubes, tube damage caused by impact of water in exhaust steam, tube abrasion resulting from sand or grit in the circulating water, tube plugging resulting from foreign matter in the circulating water, and deposits in the boiler.

One of the most important ways to reduce station maintenance requirements is to improve deaeration. Excess air in condensate results in corrosive oxide deposits in the boiler which decrease its efficiency. During 56 years of condenser design and manufacturing, C.H. Wheeler has developed a number of ways to produce deaerated condensate *in the condenser*. In special designs, they maintain oxygen content of less than 0.01 cc. per liter. Oxygen levels of far less than 0.01 per liter are often achieved in C.H. Wheeler Condensers, depending upon the amount of air leakage of the system and the amount of contaminated returns.

Basic causes of oxygen and other non-condensable vapors in condensate are system leaks, heater returns and make-up water.

Full deaeration of make-up water requires bringing it up to the temperature of the steam, so that the condensate is 100% saturated with water vapor and all gases have been driven from solution. However, to be sure that no gases are mechanically entrained in the droplets of water, the water must be agitated thoroughly to permit release of any remaining air bubbles.

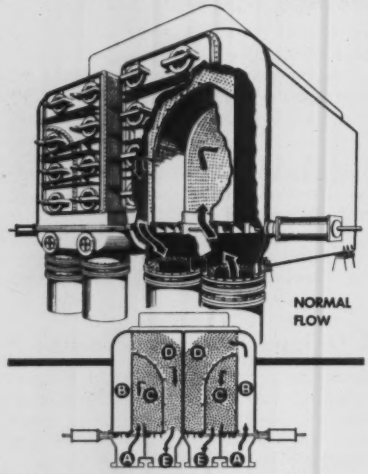



*Figure 1: Schematic diagrams of C.H. Wheeler Reverse Flow.*

In C.H. Wheeler Condensers, normal make-up water is heated to steam temperature and agitated to release non-condensables by spraying it over the top of the tube banks at both ends of the tubes, and out of the path of high-velocity steam from the turbine exhaust. Steel bars above the tubes protect them from water impingement damage. Heater drips are sprayed in the steam lanes to permit flashing and release of entrained gases.

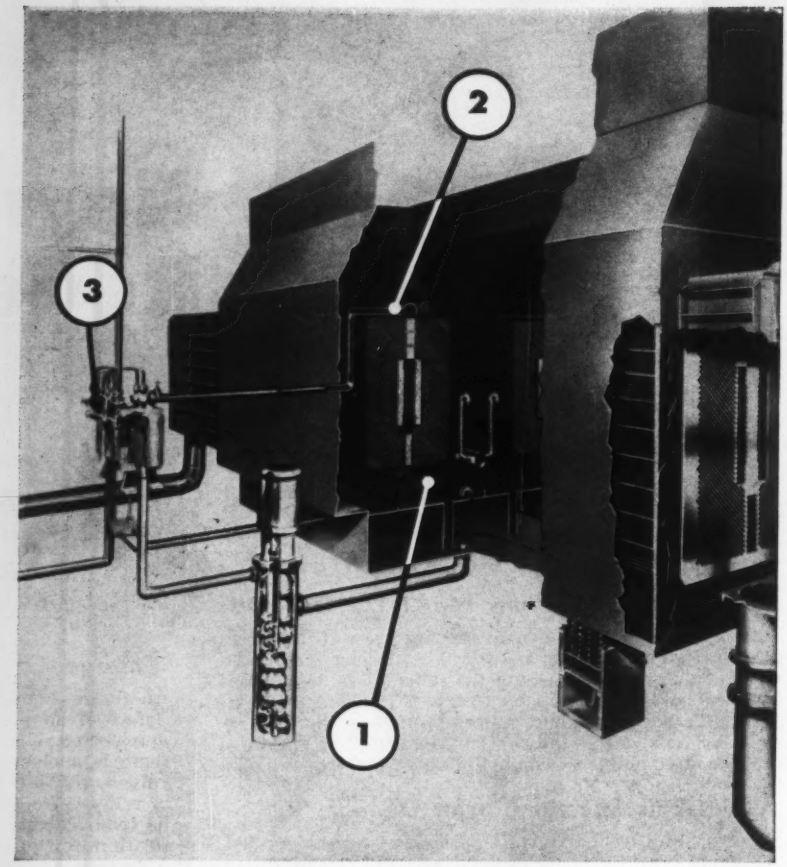



*Figure 2: Cutaway drawing of portion of C.H. Wheeler Dual Bank, Divided Water Box Condenser.*

Condensate is cascaded over deaerating bars (1, in Figure 2) in the presence of a moving blanket of steam, to provide proper agitation and reheating before it is drained into the hotwell. The Tubejet® Air Ejector (3) draws off non-condensable gases through the air-vapor suction line (2), and discharges them to the atmosphere. Central location of the air cooler section reduces depth of steam penetration and resistance to steam passage, achieving a new low in condenser pressure loss.

### Another Big Problem—Tube Cleaning

If your water supply is polluted, condenser tube deposits may become troublesome. There are several ways to correct this situation: Shooting small slugs through the tubes with high-pressure water, using acid and chlorinating the circulating water, among other methods.

One method particularly successful in removing algae, and foreign matter such as twigs, leaves and scale, is Reverse Flow (see Figure 1). Developed by C.H. Wheeler, it makes possible the flushing of tubes and sheets without shutting down the condenser.

*Here's how Reverse Flow works:* Normal operation is shown on the left. Water enters through inlet A with right inside port open, flows through tube bank C to the rear of the condenser. It returns through tube bank D to the front of the condenser, and then it discharges at E.

The right side of the diagram shows Reverse Flow in operation in a C.H. Wheeler Dual Bank, Divided Water Box Condenser. Water enters through A with outside port open, flows up through channel B and through tube bank D to rear of condenser, returns through tube bank C to front of condenser and discharges at E. Reversing can be accomplished during full load operation and full flow of circulating water, without additional pressure loss. Sluice gates for each half of the condenser move on a common stem. Each half can be back-flushed independently; or both halves can be back-flushed simultaneously with one or two circulating pumps operating.

# C. H. WHEELER MFG. CO.

**19th and Lehigh Avenue • Philadelphia 32, Pennsylvania**

*Whenever you see the name C.H. Wheeler on a product, you know it's a quality product.*

Steam Condensers • Steam Jet Vacuum Equipment • Centrifugal, Axial and Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Components

# CLUTCH AND BRAKE

They do it every day . . . because they save time, engineering costs, and design headaches by using our PROVEN, standardized clutch and brake units.

Shown here are the basic types . . . including the Industry's most successful ELECTRIC Clutches and Brakes . . . available from stock in a full range of sizes, and ready to go to work in your equipment with assured performance.

Equally valuable is the advice and practical help on special problems available to you by calling our experienced engineering department. It usually pays to "TALK MAXITORQ" first.

## SERIES 8000 ELECTRIC CLUTCHES AND BRAKES

PROVED design, Floating Disc action is fast and positive, with no heating or drag in neutral. Compact, simple, with few moving parts. For WET or DRY operation: Electrical operating unit DOES NOT REVOLVE; no brushes or slip rings. Uses easily replaced standard Disc-Pac. Requires no adjustment. Wide range of standard sizes, single and double types. All sizes rated 80 watts, operate on 110 V.A.C., rectified to 90 V.D.C. Other voltages on special order.

## SERIES 9000 ELECTRIC CLUTCHES AND BRAKES

Operation is induced entirely by magnetic flux which provides fast response. There are no brushes, slip rings, stressed parts or wiring problems. Flexibility of control, compact design, drag-free neutral, ease of installation, suggest a wide range of applications from simple machines to punched tape or other automated equipment. They operate on 90 V.D.C. rectified from 110 V.A.C. Other voltages on special order.

## STANDARD FLOATING DISC CLUTCHES AND BRAKES

MAXITORQ offers you PROVED performance in every type of service with the following important advantages: compact design with few and sturdy parts . . . floating neutral with no heating or drag . . . positive engagement or release with light pressure . . . manual assembly and adjustment . . . full range of sizes and types . . . supplied as a completely assembled and easily installed unit.

## OVERLOAD RELEASE CLUTCHES

One of the simplest and most efficient methods of providing a DEPENDABLE and easily adjusted overload release feature combined with a clutch. Incorporates all the advantages of MAXITORQ Floating Disc design plus automatic and complete release upon overload. Proved in service. Available in a wide range of sizes.

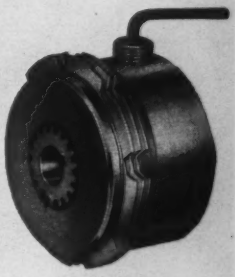
## DISC-PAC

The "heart" of the SERVICE-PROVED Maxitorq Floating Disc Clutch in a compact, assembled unit for those who wish to design and build their own clutch mechanisms. Supplied as complete units ready for use in 8 diameters 2" to 8", up to 800 ft. lbs. capacity. Also useful as a multiple disc brake or torque limiting device.

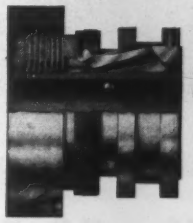
## JOHNSON SINGLE DISC CLUTCHES

The modern, low cost, dependable clutch for light machinery drives to 6 h.p. Smooth, positive, long service. No matter what your clutch needs, discuss them FIRST with our engineers.

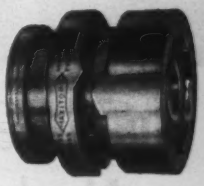
Series 8000 Electric Clutch



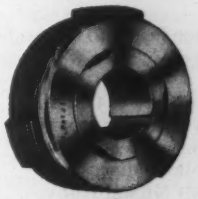
Series 9000 Electric Clutch



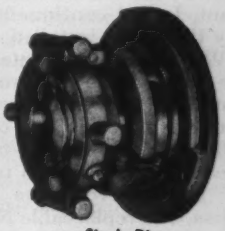
Standard Clutch



Overload Release Clutch



Disc Pac



Single Disc Clutch

Write Dept. AM for details on any of the above products and specify product by title.

**Maxitorq**

THE CARLYLE JOHNSON MACHINE COMPANY

3CJ59

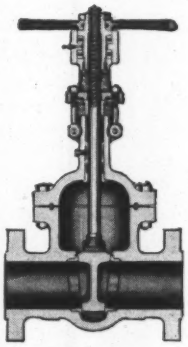
# Replaced leaking valves with Crane gates No leaks...no maintenance...in 2 years

New gate valves, installed on steam lines to and from a fire-watch pump at a gasoline plant, leaked continually, almost from the day they were installed.

When frequent maintenance failed to stop the leaks, Crane steel wedge disc gates were installed. One valve was a 3-inch, 300-pound No. 33XR; the other one, a 4-inch, 150-pound No. 47XR—both rated for steam service at a maximum temperature of 850° F. Both valves have Exelloy discs and stems, and replaceable No. 49 Nickel Alloy, screwed-in body seat rings.

The switch to Crane valves was made two years ago. Since then, they have been in continuous operation. Not *one* leak has developed—and not *one* cent has been spent for maintenance.

Get the jump on your costly maintenance problems. Make original as well as replacement installations with Crane valves and other piping materials. For all facts about the many Crane valves used for refinery, pipeline and other services, see your Crane Representative or write to the address below.



Typical cross section of Crane steel wedge disc gate valves widely used in refinery, power and process services. Available in sizes up to 48 inches; for oil or oil vapor, steam, air, gas, gasoline, water and other services. In seven pressure classes—150-pound to 2500-pound, with temperatures to 1100°F. Choice of trim materials is most complete. Write for details.

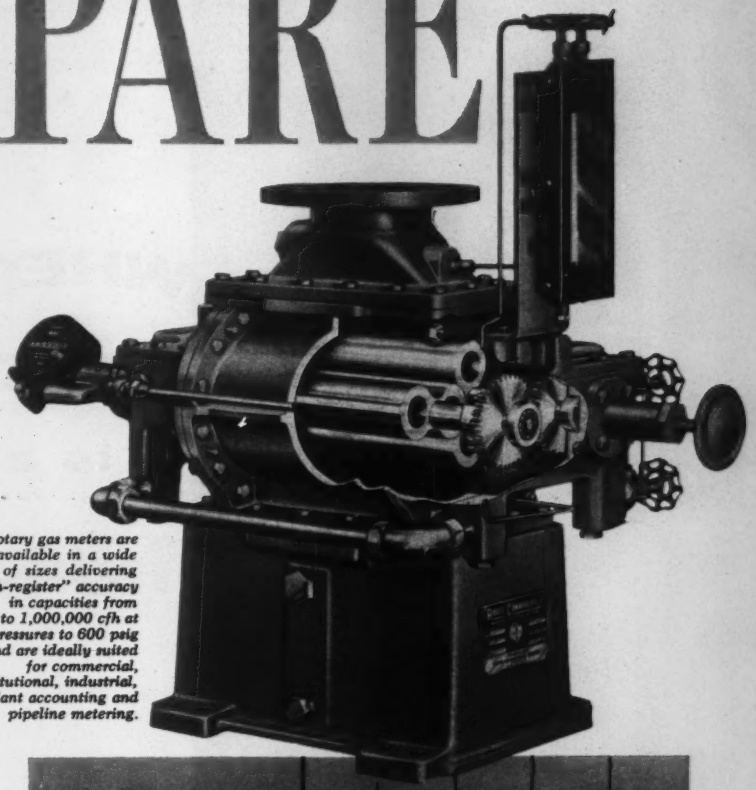
**CRANE® VALVES & FITTINGS**

**PIPE • PLUMBING • HEATING • AIR CONDITIONING**

*Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas*

# COMPARE

## More Capacity At Less Cost With R-C Rotary Gas Meters



*R-C rotary gas meters are available in a wide range of sizes delivering "cash-register" accuracy in capacities from 2,000 to 1,000,000 cfh at pressures to 600 psig and are ideally suited for commercial, institutional, industrial, interplant accounting and pipeline metering.*

| Comparative Analysis | SPACE OCCUPIED | TOTAL CAPACITY | METER COST | INSTALLING COST | TOTAL COST |
|---|---|---|---|---|---|
| FOUR DIAPHRAGM METERS | ▬ | ▬ | ▬ | ▬ | ▬ |
| ONE R-C METER | ▮ | ▬ | ▬ | ▮ | ▬ |

As the comparative chart indicates, cost is reduced and capacity is increased with R-C rotary positive displacement meters. The total capacity of one R-C meter exceeds that of two or more diaphragm meters. Both initial cost and installing costs are substantially lower. Their small space requirements permit installation in otherwise unusable space. And operating costs are held to a minimum, since maintenance is confined almost entirely to lubrication of gears and bearings and to an occasional check of the operating differential.

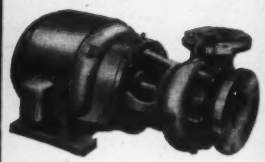
Roots-Connersville rotary positive displacement gas meters provide a 15:1 operating range – metering unmatched by any other design. Precision-machined measuring chambers insure unalterable accuracy unaffected by variations in specific gravity, rate of flow, pulsations or impurities. And there are no valves, diaphragms or other small parts to wear and cause inaccuracies.

Pressure drop is minimized, since R-C's straight-through design eliminates winding passages and restricting ports. Even at low flows, these meters retain "cash-register" accuracy. These advantages are the result of R-C's specialized experience of more than 100 years in the design and application of air and gas handling equipment.

*For additional data, please refer to pages 565-568 in* **Chemical Engineering Catalog,** *our section in* **Mechanical Catalog** *or write for* **Bulletin M-258**

**ROOTS-CONNERSVILLE BLOWER**
**DIVISION OF DRESSER INDUSTRIES, INC.**
**639 Michigan Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto**

# WHERE SPACE is a PROBLEM



## "BUFFALO" CLOSE-COUPLED PUMPS

For high-performance pumping in a limited space your best answer is a "Buffalo" Close-Coupled Single Suction Pump. Here's why:

- Easy and Economical to Install: Wide flexibility in piping and mounting are provided by adjustable discharge angle and permanently aligned shafts.
- High Efficiency: Enclosed type impeller is designed for maximum pumping performance.
- Durable and Dependable: Sturdily built with heavy cast mounting brackets, husky shells, accurately machined impellers and deep stuffing boxes.
- Quiet, Smooth Operation: Careful static balancing of impeller assures smoothness, low noise level.
- Wide Range of Sizes and Capacities: 1″ to 6″ discharge sizes. Capacities up to 1100 gpm.

The next time you need clear water pumping efficiency to fit into close quarters, ask your "Buffalo" engineering representative for full details on "Buffalo" Close-Coupled Pumps. Or write for Bulletin 975-F.

*"Buffalo" pumps bring you the famous "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life.*

"Buffalo" PUMPS

**BUFFALO PUMPS** DIVISION OF BUFFALO FORGE COMPANY

148 Mortimer Street, Buffalo, N. Y.

Canada Pumps, Ltd., Kitchener, Ont. • Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

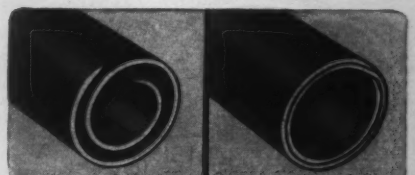
# Bundy can mass-fabricate practically anything

## ...and we use Bundyweld®—the double-walled steel tubing—for parts that must meet rigid specifications

YOUR tubing headaches are Bundy's business. Our tubing engineers will work with you at any stage in the development of your product. With years of problem solving experience, we can often suggest short cuts that cut costs of tubing parts—or find practical solutions to tough bends.

Then we'll mass-fabricate these parts on machines specially designed by Bundy for precision bending. We use Bundyweld, the original double-walled steel tubing, that has become the safety standard in small-diameter tubing. It's thinner walled—yet stronger, has high bursting and fatigue strengths.

Why don't *you* take advantage of Bundy's complete service: expert engineering help, mass-fabrication savings, *Bundyweld* tubing. For more information see Sweet's Product Design File, le/Bu . . . or contact us!



**Bundyweld is the only tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.**

**Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ½" O.D.**

*There's no real substitute for Bundyweld Tubing*

# BUNDY® TUBING COMPANY

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WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY

NEW EDWARD IMPACTOGEAR

*What's New from Edward Valves*

New Products . . . Solutions to Problems . . . Information on Steel Valves from Edward, Long-Time Pioneer in the Field!

# How Impactogear* operates high-pressure valves

You no longer need a crew of men to open or close big, high-pressure valves. New Edward Rockwell-built Impactogear makes big-valve operation a quick and easy job.

### FAST AND EASY "RUNDOWN"

Your operator simply applies portable air or electric wrench to pinion shaft-end of Impactogear. When power is applied, pinion turns ring gear, which turns handwheel and moves the stem to "closed" position. Impactor* handwheel then gives final tight shut-off with unique "hammer-blow" action. (Tests show it delivers 12 times the closing force of ordinary handwheels—with less effort!) Impactogear works quickly, can operate a 2500-lb 10" valve (for example) in only 2½ minutes. And Impactogear can be fitted to any 8" or larger Edward valve of 900-lb (or higher) pressure class.

### IMPACTOGEAR WITH AIR WRENCH

Impactogear utilizes standard portable air or electric wrenches generally available throughout industry. Example below shows how two typical air wrench ratings can be applied:

**Wrench Type No. 1—Stall torque 170 ft-lbs: Free speed 225 rpm; Weight 12 lbs**

For 12" and 14" 2500 lb. valves, operating pressures to 3500 psi

For 10" 2500 lb valves, all allowable operating pressures

For 10", 12" and 14" 1500 lb valves, all allowable operating pressures

For 12" and 14" 900 lb valves, all allowable operating pressures

**Wrench Type No. 2—Stall torque 200 ft-lbs: Free speed 300 rpm; Weight 38 lbs**

For 12" and 14" 2500 lb valves, operating pressures 3500 psi to 4500 psi

### IMPACTOGEAR WITH ELECTRIC WRENCH

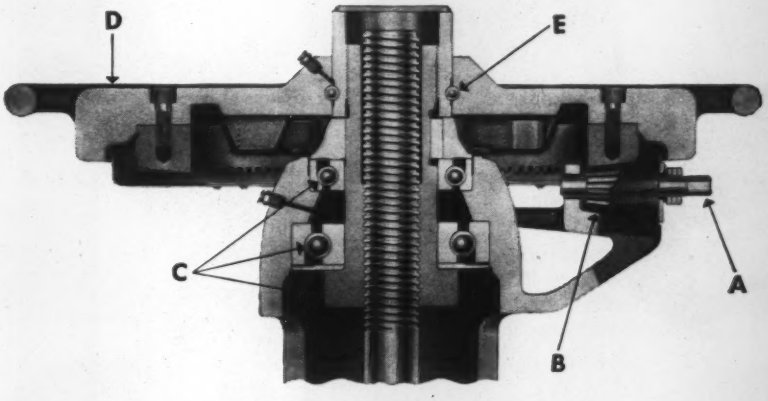
Portable electric wrenches are equally practical. Example below shows a typical electric wrench rating as applied to Impactogear:

**Wrench Type No. 1—Stall torque 176 ft-lbs: Free speed 225 rpm; Weight 44 lbs**

For 10" 2500 lb valves, all allowable operating pressures

For 10" and 12" 1500 lb valves, all allowable operating pressures

For 12" and 14" 900 lb valves, all allowable operating pressures




**Details of new Impactogear and Impactor Handwheel:**

A—Hex head of pinion gear shaft. Power wrench is applied here. B—12-to-1 bevel gear ratio is typical for median size handwheel. C—Exclusive EValthrust yoke bushing combines radial and thrust bearings for easy operation and long life. D—New Impactor handwheel concentrates mass near outer circumference for maximum impacting efficiency. E—New extra bearing increases operating efficiency.

### SLASH COST OF VALVE OPERATION

Individually installed operating motors are a big investment. They can add as much as 100% to the basic valve cost. *But now you can save that money by standardizing on Impactogear*—radically simple, thoroughly dependable mechanism utilizing *existing* compressed air or electric facilities. Your Edward Representative will be glad to provide full details and help you determine how Impactogear can work to your best advantage. Contact him—or write *Edward Valves, Inc., 1228 W. 145th Street, East Chicago, Indiana.* (Subsidiary of Rockwell Manufacturing Company). Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W., Montreal 1, Quebec.

**LIGHTWEIGHT PORTABLE WRENCH** can operate as many Impactogear-equipped valves as desired. Or, each valve can be fitted with its own wrench. Either way, you get lower operating costs. Final closing is effected by handwheel lugs (A) striking hammer blows against cross arm keyed to yoke bushing (B). Half of gear cover was removed for illustration purposes.

*T.M. Reg. U.S. Pat. Off.

EDWARD STEEL VALVES
another fine product by
ROCKWELL

Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.

# The MARSH way is the SURE way—

You'll have a new conception of how *uniformly good* radiator valves, traps and vents can perform when you make the job Marsh all the way through.

Take the Radiator Valve and Trap illustrated here, for instance:

The Marsh Radiator Valve is *truly* packless—not just *called* packless. This valve has no "packing" whatever... instead, the ingenious Marsh annular mechanical seal that keeps it drip tight throughout its far longer life.

And Marsh Radiator Traps are equally sure-footed... have the famous Marsh Diaphragm—extremely rugged, but so sensitive that it never fails to close tight on steam, yet opens instantly to pass condensate and air at only a few degrees below closing temperature.

Yes, the Marsh way is the sure way...Valves, Traps, Vents, F & T Traps, designed, built and tested to give lasting satisfaction in the Marsh tradition. Ask for up-to-date Heating Specialties Catalog 76-H.

**MARSH HEATING EQUIPMENT CO.**
*Sales Affiliate of Jas. P. Marsh Corporation*
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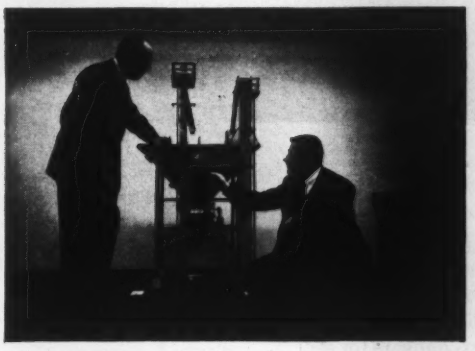
8407 103rd St., Edmonton, Alberta, Canada

**MARSH** *Heating Specialties*
SINCE 1865

*Bill St. John (left) with Heltzel Chief Engineer, W. J. Kirchner, who said: "As a result of Bill's recommendation, we're using Jeffrey's combination chain. It's economical, yet gives the needed strength in our higher elevators."*

# "Jeffrey gives us the kind of service we want"

*Heltzel buyer, John Holodnak (right): "It's strictly service as far as Jeffrey is concerned with us. Jeffrey gives us quotations in two days or less. They stock for us. Delivery is no problem."*



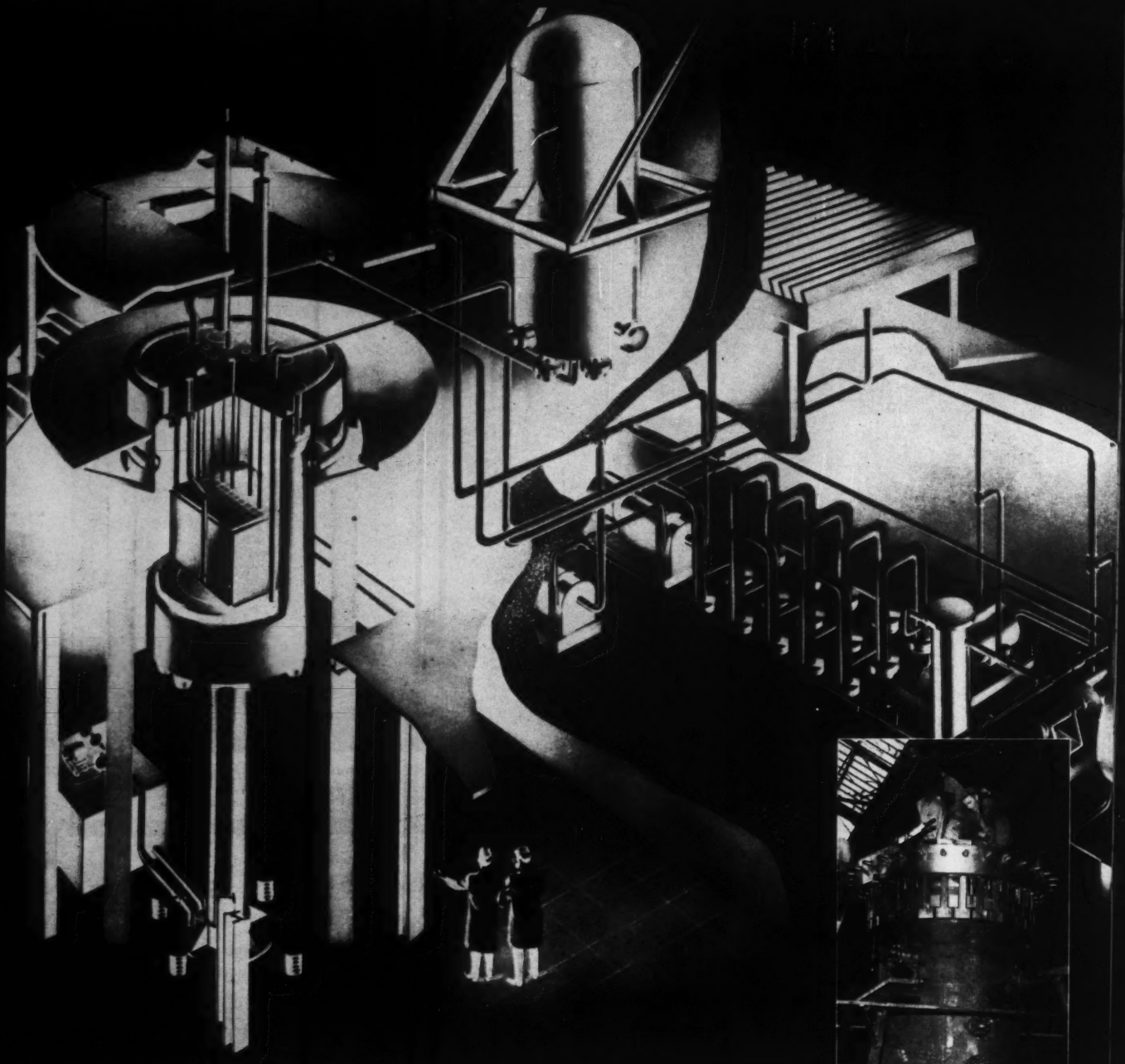
The Heltzel Steel Form & Iron Company, of Warren, Ohio, manufacturer of concrete batching plants, now looks to Jeffrey for power transmission components. Heltzel engineers and buyers agree that Jeffrey gives them the kind of service they want.

Commenting on Jeffrey service, Heltzel Chief Engineer, W. J. Kirchner stated, "Originally, Jeffrey's Director of Research came to Heltzel with Bill St. John (Jeffrey Northeast Ohio Sales Engineer). They sat down and discussed our needs—Bill knows what he's talking about. We understand each other. We have followed his recommendations in many instances."

Find out exactly how Jeffrey delivers the kind of service you ought to have. Arrange a meeting through the Jeffrey office nearest you, or contact: Manager, OEM Sales, The Jeffrey Manufacturing Company, 915 North Fourth Street, Columbus 16, Ohio.

JEFFREY

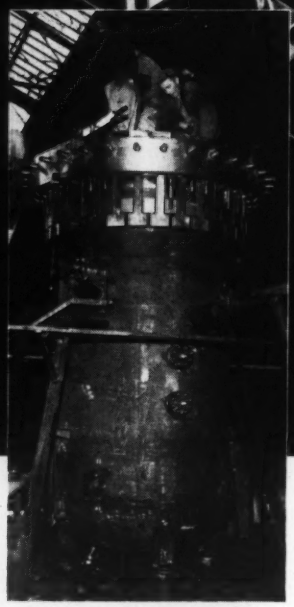
CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING



# FIRST EVER BUILT

—this high-temperature nuclear test reactor was developed by Knolls Atomic Power Laboratory to confirm design data for reactor cores of the submarine Triton. Vital core components and instrumentation are housed in a 32½-ton stainless steel pressure vessel. Required to withstand 550 F., 1,500 psi, this vessel and its novel, quick-opening closure were designed and fabricated for KAPL by The M. W. Kellogg Company.

Additional examples of Kellogg's ability to design and fabricate nuclear equipment to the most exacting standards include the primary coolant stainless piping for two other nuclear plants. Kellogg is also designing and fabricating heat exchangers for still another nuclear plant. Kellogg's Fabricated Products Sales Division welcomes inquiries for the design and fabrication of nuclear equipment.



The Proof Test Reactor Pressure Vessel, with quick-opening closure, in Kellogg's Jersey City plant just prior to shipment.

**THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17, N. Y.**

A SUBSIDIARY OF PULLMAN INCORPORATED

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# MECHANICAL ENGINEERING

VOLUME 81 • NUMBER 6 • JUNE, 1959

Just 75 years ago a group of men interested in electricity founded our sister society, the American Institute of Electrical Engineers. Today, as in 1884, the objectives of AIEE are much the same: To hold meetings, to read and discuss technical papers, and to circulate the information by means of publications, as well as to promote "social intercourse" among its members.

To commemorate the Institute's Diamond Jubilee, Editor Charles S. Rich and his staff have devoted the May, 1959, issue of *Electrical Engineering* to a summary of progress during the past 25 years. (The May, 1934, issue of *Electrical Engineering* reviewed technical progress during AIEE's first 50 years.)

Among the engineering luminaries who contributed articles to the anniversary issue are C. Guy Suits, the late Donald Quarles, E. W. Engstrom, T. J. Watson, Jr., Philip Sporn, Walker Cisler, A. C. Monteith, C. F. Wagner. And they have chronicled an enormous amount of information much of which is of interest to mechanical engineers. Examples: The great scientific discovery of nuclear fission and its power generation applications; television; the invention of the transistor that led to a whole series of semiconductors and solid-state devices which, coupled with printed circuits, the ferrite series, and subminiature tubes, extended miniaturization; electronic computers; the placing of satellites and man-made planets in orbit which involves a whole series of electrical problems for instrumentation, control, guidance, and telemetry, as well as the necessity for high-speed computers to process large amounts of tracking data.

Mechanical engineers in the power field will also be interested in the remarkable growth of the electric-power industry over the past 25 years. Power generation expanded well over 700 per cent or at a rate nearly $2^1/_2$ times as fast as the increase in the gross national product. Milestones: Greatly increased sizes of units, new insulating materials, the silicones, plastics, polyethylene, grain-oriented steels, hydrogen cooling, supercritical pressures.

The Mechanicals through ASME have always been related closely to the Electricals. Founded four years earlier, in 1880, there are remarkable similarities surrounding the birth and early development of these two engineering societies: A growing industrialized society in the background, a country shedding its pioneer and agricultural make-up, a rapidly developing group of fundamental sciences and educational facilities, a common interest for engineers to band together, and a limitless opportunity for the useful expansion of technology for the betterment of mankind.

Today both organizations still maintain their close relationships. There are numerous joint ASME-AIEE Conferences: Railroad, Power, Engineering-Management. Both Societies also participate actively in the American Power Conference, Nuclear Congress, and the Automatic Techniques Conference. They also co-operate in certain areas of standardization and in the conferring of numerous honors and awards.

As Founder Societies, both are engaged in the current Member Gifts Campaign for the proposed United Engineering Center. In this effort, the Electricals are outdistancing the Mechanicals by a large margin. Dollar facts: AIEE goal, $900,000—gifts subscribed thus far, $744,000 or 82.7 per cent; ASME goal, $800,000—subscriptions thus far, $496,000 or 62.1 per cent.

Thus AIEE culminates 75 successful years of service to the engineering profession, capping them off with a Member Gifts Campaign that is also on its way to successful completion. For past achievements and alertness to the future needs of the profession, AIEE is to be congratulated.—*J. J. Jaklitsch, Jr.*

**Editor, J. J. JAKLITSCH, JR.**

**Editor Emeritus, GEORGE A. STETSON**

# Human Engineering

*How it began...What it is...Some of the methods used...Where the future may lead...*

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HUMAN ENGINEERING got its start early in World War II. Before that time, psychologists in industry and government had been busy with problems of selecting and training men to fit machines. With the war, however, entirely new aircraft-control systems, radar gear, submarine sonars, gunnery systems, and other equipment were being developed. System reliabilities were often poor. Accident and injury rates were high. Careful manpower selection and training just weren't enough. Man-machine combinations weren't doing the jobs for which they were planned. The reason for this impasse was that machines were often making impossible demands of their human operators.

What were some of these demands? In general, to operate some of these devices you needed a man with two heads, the arms of an ape, no legs, and ten fingers on each hand. More specifically, there were the now-familiar problems of console design, fatigue and monotony, unusual environments, and of "seeability," "reachability," and "sittability." These are problems the layman commonly associates with human engineering. But there were other important problems as well. There was the problem of deciding, early in system development, what sensing, data-processing, and response outputs should be assigned to man. There was the problem of identifying the information that should be picked off a machine for display to an operator performing a monitoring task. There was the problem of designing a servo system with an intermittent, nonlinear human operator right in the middle of the loop. There was the problem of measuring and controlling variations in the day-to-day performance of a single individual and within groups of individuals.

In approaching these problems the human engineer had at his disposal two powerful tools. One was a detailed knowledge of human behavior that had accumulated over the 100 years during which psychological research had been conducted. True, there were gaps in this knowledge, but there was much of value. The fact that the eye can resolve two points as close together as 44 sec of arc, for example, was of help in establishing the resolution of visual displays, such as cathode tubes. The knowledge that man can respond to a light as rapidly as 200 millisec after its onset was useful in selecting the buffers needed between a manual and a high-speed electromechanical process. In addition to such established facts, the psychologist also had at his disposal techniques for conducting research on human beings to establish new facts. He could perform controlled experiments, vary given values of a variable, and measure the effect on human performance. In this way data were accumulated on man's ability to dark adapt while wearing red goggles, to withstand extremes of temperature, pressure, and humidity, and to make precise settings on a scope display. The sizes of handwheels, cranks, foot pedals, their locations, and optimum forces were established. Similar studies were made for displays.

Two things are clear about such findings. They are not the product of common sense, although they sometimes verify common sense. Common sense doesn't tell you a man can't tell the difference between a tone of 900 cps and one of 905 cps. It doesn't tell you that if you expose the eye to 50 bits of information per second you will lose about $1/3$ in transmission. These facts are known only after careful research.

The second thing that is clear about these findings is that they aren't of value to the designer unless he knows when in development to apply them. Some kind of schedule is needed to integrate human-engineering objectives and methods with over-all system engineering. Just as there is a procedure for engineering development, there should be a procedure for recognizing and solving human-engineering problems as the system grows from requirements to blueprints, to prototype.

### Relation Between Engineering and Human Engineering

The relation between engineering and human-engineering phases in development is illustrated in Fig. 1. The first column may be thought of as a succession of engineering steps, beginning with the establishment of system requirements, and ending with the field use of the finished production machine. The second column lists the objectives of the human engineer during these successive steps. The third column lists the general methods he may employ in meeting these objectives. Of course, not all systems go through these six separate, distinct phases of development. If time is short, several phases may be accomplished simultaneously. But let us consider them separately.

The first two are considered here because they are the

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[1] Department 537.

Contributed by the Management Division and presented at a joint session with the Aviation Division and Human Factors Society of America during the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 58—A-239.

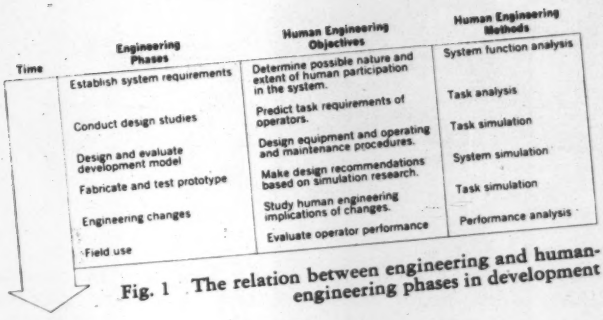



Fig. 1 The relation between engineering and human-engineering phases in development

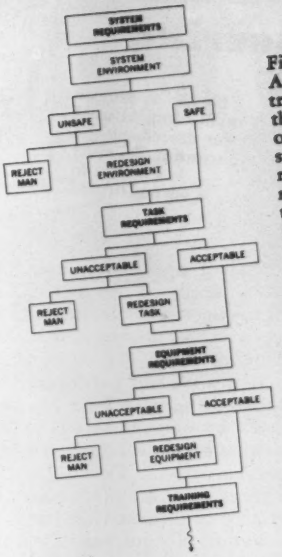



Fig. 2 A decision tree showing the analysis of the system requirements and the steps followed in reaching decisions on the equipment to be used

most important as well as the least recognized. The others, beginning with task simulation, are more readily recognizable as the study and evaluation of consoles, displays, controls, and the static and then functional pieces of hardware that grow out of the first two phases.

### System-Functions Analysis

System-functions analysis is the process of identifying the jobs a system must perform to accomplish its over-all purpose. Although it is primarily within the domain and responsibility of the design engineer, it is important that the human engineer participate in it if proper consideration is to be given to the human in subsequent phases.

A weapon system whose purpose is to defend a friendly ground base from attack by enemy airborne weapons will illustrate how this type of analysis looks to the human engineer. A logical breakdown of the over-all purpose might result in several subfunctions such as detection and identification of the enemy, tracking the position of the enemy in space and time, controlling or deciding upon a course of action, and evaluation of the results of this action.

Which of these functions, if any, will be assigned to man? There are numerous possible criteria: reliability, cost, relative capabilities of men and machines, logistics, and so on.

A mission map is of great use at this point. On it can be plotted the take-off and landing points, probable course, the terrain, expected altitude and speed capabilities, possible attack environment, and other factors that will affect operation. Given these facts, or rather guesstimates, it is possible to arrive at a preliminary decision on the component to be used for each subfunction. Note that it is still unspecified whether the weapon will be manned or unmanned.

Clearly, if the system is to fly through a highly radioactive area and there is no known means of protecting the pilot, he will be eliminated as an airborne controller. But if this problem doesn't exist, other factors should be considered. Suppose it is tentatively decided to let the pilot be the controller. Next, it must be known what maneuvers the system must execute and how fast they have to be accomplished. If the speeds are clearly outside the limits of human reaction time the man is again ruled out. If they aren't, the next factor that would be considered is the decisions the system may have to make. Many of these can be programmed. Others cannot. For those that cannot be anticipated in advance a man will be highly useful. So let's assume that a second man is put into the system as a controller. What is next?

Now the naked eye cannot be expected to be a reliable long-range sensor, and a man can't be expected to hold and process all of the information he must use in his head. At least two types of aids are needed: a sensing device, and a storage device. Assume that radar is used for the sensor, and a plotting board for storage. Knowing the characteristics of the man, certain statements can be made about how these two pieces of equipment should be designed. It can be said that the resolution of the radar scope should be at least 2 min of arc to permit the eye to distinguish one pip from another. It can be said that the brightness contrast between a single pip and the scope background should be in the ratio of 1 to 5. Similar statements can be made for the plotting board and whatever voice or other communications techniques are used.

The first method, thus far, can be broken into five separate steps. First, the requirements for the system have been studied. From these requirements, predictions have been made about the system environment and a decision has been made as to the advisability of including man. Having decided to include him, the function required of him can be analyzed into three parts: sensing requirements, data-processing requirements, and output requirements. Where man was unable to sense information, process it, or produce a response output without assistance, the kinds of equipment that would help him perform these functions and the characteristics it must have to be effective were stated. This chain of events follows a decision tree. Fig. 2 gives a crude idea of how it looks in the abstract.

### Prediction of Task Requirements

Assume that the first human-engineering objective has been achieved. The second, namely, the prediction

| Job Element | Control | Action | Indication | Alternatives and/or Precautions |
|---|---|---|---|---|
| 1.1.1 | POWER Switch | Turn to WARM UP | Inverter hums, pilot light comes on. | Make sure covers are on high voltage units before starting task. |
| 1.1.2 | AC VOLTAGE (screwdriver) | Turn as required | AC voltmeter aligns to 117 4 volts. | |
| 1.1.3 | | Wait maximum of 5 minutes | READY light comes on. | If READY light does not come on, use press to test button. If light is burned out, replace it. |
| 1.1.4 | METER SELECTOR switch | Turn to 300 | | |
| 1.1.5 | 300 VOLTS ADJ. (screwdriver) | Turn as required | Meter indicates within green area. | |
| 1.1.6 | METER SELECTOR switch | Turn to −150 | | |
| 1.1.7 | −150 VOLTS ADJ. (screwdriver) | Turn as required | Meter indicates within green area. | |

Fig. 3 A sample of the format used for describing the discontinuous tasks that are to be performed

of the task requirements of operators, should then be considered. Predictions need to be made for both equipment design and for operator-selection and training criteria. Essentially, a task analysis is a detailed, step-by-step description of what the operator does in performing his job. It is a way of listing in systematic form the things a man will have to look at, the things he will have to think about, and the things he will have to do to controls or displays to fulfill a given subfunction that has been assigned to him. Task descriptions of this type, either for operators or maintenance technicians provide a valuable source of information for the design of work areas, the layout of equipment within these areas, the design of controls and displays, and even about the skills and knowledges that may be needed to perform the job. Fig. 3 illustrates how such an analysis may be laid out. It is an example taken from the job of line mechanic on a fire-control system.

Now, there is nothing magical about this analysis. In fact, the task description is only the basis for subsequent analysis of a logical or research nature. If such an analysis is made early in development, work can be done in a systematic, programmatic fashion on each of the many details that are bound to arise in locating the controls, displays, and other items of equipment with which the man will work.

Both of these methods that have been described, if used early enough, will lead directly and efficiently to the early stage of hardware development. They are methods that can be used by the designer himself, as well as by the human engineer.

If these methods are followed, if the human being is considered at the right points early in development, a great deal is to be gained. First, human engineering is introduced early enough to save money on occasion by trading off a man for a machine component where the man does at least as well as the machine, at less expense in equipment. Second, the chances of getting a piece of hardware that can't be operated and that would be prohibitively expensive to change to an operable item are lessened. Third, the engineers know the order in which to expect human-engineering problems.

### Future Possibilities

Human engineering, even though it is an applied field, often a service function, is on the threshold of several important breakthroughs that should have some dramatic consequences for machine design. Many of these developments are of the Cloud 38 variety; others are nearer reality.

We have within our means fragments of the knowledge needed for direct brain-to-machine communications without the necessity for the intervening display devices that are now used. This type of communication might consist of tapping electric potentials from various brain centers, and using them as inputs to a system. Rather than communicate with a machine by means of such artificial languages as punched cards or even direct voice communication, the system could be provided with certain portions of thoughts and images which would help it to converge upon the solution.

A second possible development for future man-machine systems is that of building machines that are both training and operational devices. They would teach new operators and maintain proficiency in already-trained operators by providing knowledge of results, by gradually increasing the tolerances demanded of an operator, and by providing rewards for excellent performance. Crude systems of this type are already in existence.

A third breakthrough should occur in the field of control-device design. We have already witnessed many remarkable developments in the display field, but we are backward in control systems that permit man to make rapid and accurate inputs to a system in a form that is natural to him. Finally, there will be less dramatic but nonetheless important breakthroughs in such fields as the measurement of individual behavior, the precise assessment of the level of a person's motivation to do a job, the knowledge of the information-carrying capacity of the various sense organs, intervening brain centers, and motor-response systems. This latter information will be of great help in establishing limits for the rates and kinds of information we feed to men from machines.

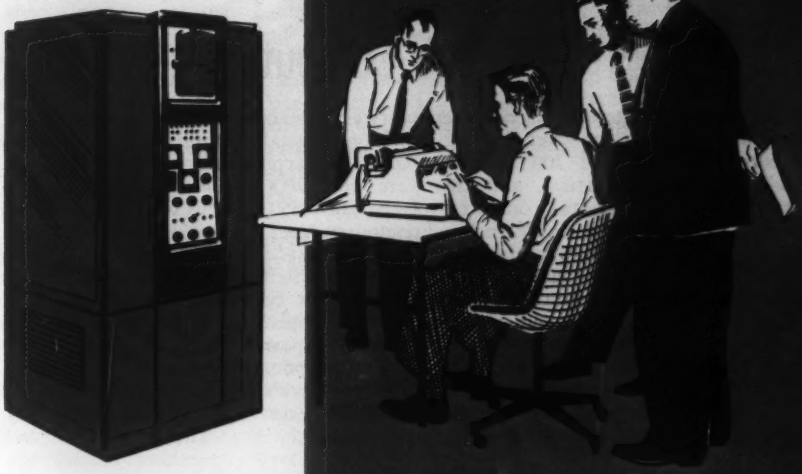
### Conclusion

In conclusion, human engineering is a young and unfamiliar field. It is sometimes misunderstood and misrepresented. But the rewards in improved machine operability, increased system reliability, and greater usefulness of man-machine systems to mankind have already been great. The unique contributions of human engineering are a combination of knowledge of human behavior and methods for the study of unknown areas of behavior with appreciation for the engineering problems of system development. More will undoubtedly be heard about it in the future.

### Bibliography

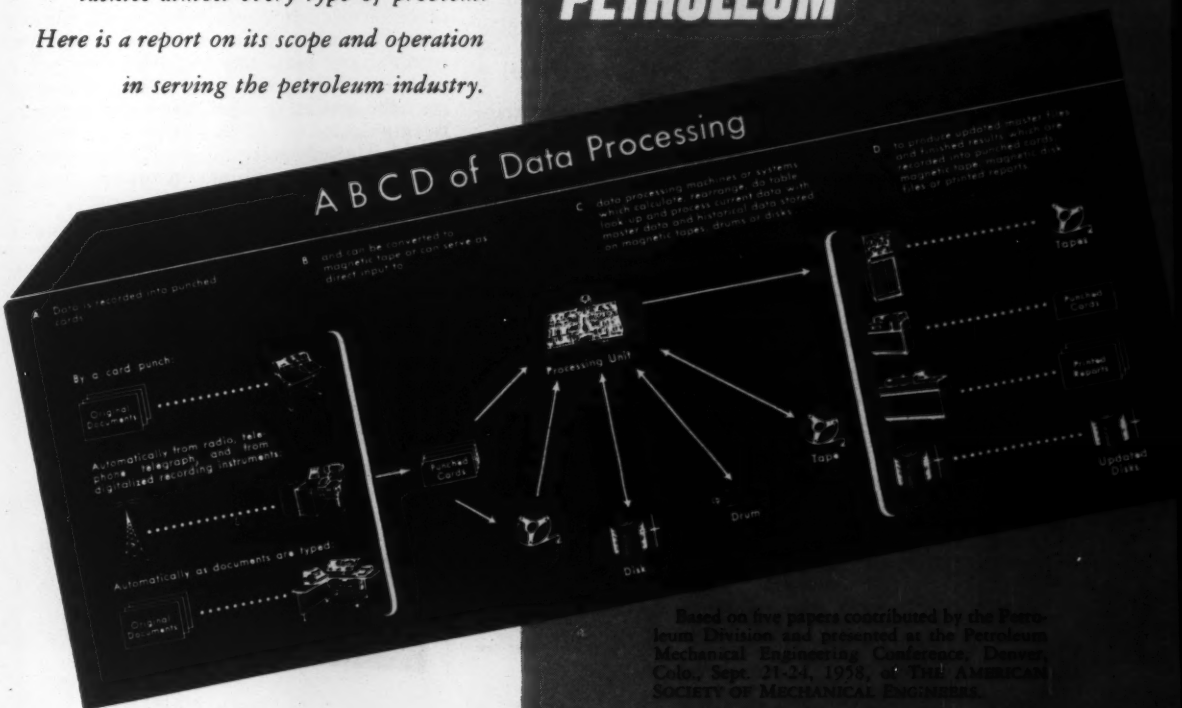
H. W. Sinaiko and E. P. Buckley, "Human Factors in the Design of Systems," Naval Research Laboratory, NRL Report No. 4996, August 29, 1957.

H. P. Van Cott and J. W. Altman, "Procedures for Including Human-Engineering Factors in the Development of Weapon Systems," Wright Air Development Center, Technical Report No. 56-488, Oct., 1956. ●



# ELECTRONIC COMPUTERS FOR PETROLEUM

*With computer technology scarcely more than ten years old, the machine tackles almost every type of problem. Here is a report on its scope and operation in serving the petroleum industry.*


A B C D of Data Processing
A Data is recorded into punched cards
By a card punch
Original Documents
Automatically from radio, telephone, telegraph, and from digitalized recording instruments
Automatically as documents are typed
Original Documents
B and can be converted to magnetic tape or can serve as direct input to
Punched Cards
C data processing machines or systems which can collate, rearrange, do table look-up and process current data with master data and historical data stored on magnetic tapes, drums or disks
Processing Unit
Tape
Drum
Disk
D to produce updated master files and printed results which are recorded into punched cards, magnetic tape, magnetic disk files or printed reports
Tapes
Punched Cards
Printed Reports
Updated Disks

Based on five papers contributed by the Petroleum Division and presented at the Petroleum Mechanical Engineering Conference, Denver, Colo., Sept. 21-24, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

# The Computer at **WORK**[1]

THE electronic computer is only ten to twelve years old, and yet there are over 200 of the large digital computers of the IBM 700 Series or UNIVAC type installed and in operation, and there are over 2000 of the medium-size digital computers of the IBM 650, Electro Data, Bendix 15, and Rem Rand computer types.

Three years ago it was popular to appear in print and before professional meetings and extol the unlimited virtues of electronic digital computers. As might be expected, a reaction has set in, and it appears to be just as popular today to write rebuttal articles and appear before the same professional meetings and point out the shortcomings, the high costs, and other faults of these expensive computation and processing systems. The truth undoubtedly lies between the two extremes.

### Computers for Rent

There does not seem to be too serious a question as to the economic operation and complete justification of small and medium-size digital computers of the LGP-30, Bendix G-15, and IBM 650 types, which rent from $2000 to $4500 per month. There does not seem to be a question of the pay-out and economics for all types of digital computers—small, medium, and large—that are used primarily for engineering, scientific, and operating uses. In this case, the rentals range from $1000 per month to as much as $50,000.

The main area of current management doubt is confined primarily to large-size computers that have been installed solely for data processing and accounting applications. This condition probably exists because computers were originally designed for high volume mathematical work rather than for handling and manipulating large volumes of paper work common to accounting applications where the computational requirements are at a minimum.

The introduction of electronic computers has contributed greatly to the rapid growth of "operations research" type work. This so-called scientific approach to management decision-making, which by and large uses various mathematical analysis techniques, has in many cases justified the use of computers, and there is no doubt that this growing area will be increasingly dependent upon the high-speed data processing and computing made possible by electronic digital computers.

### Operating the Computer

We have seen in just the past few years a major breakthrough in the education or experience requirements needed to make use of a computer. It was only a few years ago that any professional person desiring to use the high-speed computational help afforded by the computer had to receive extensive computer training to be able to write the necessary machine "programs."

Further, each computer had its own unique "language," or command structure. Fortunately, today, the machine to quite a degree can "program itself"; that is, there are "shorthand" systems of writing necessary machine codes and instructions. These are generally known as compilers or assembling programs. Thus we now find that it is only necessary to give several days' special training to any qualified engineer to enable him to use the IBM 650 IT compiler or the large 704 Fortran coding systems. All the other machines have comparable compilers or machine shorthand-programming systems.

There is significant work being done to adopt a universal "language" whereby any type or make of computer will be able to handle properly written instructions in a new, universal shorthand or language.

There are now 2000 to 3000 digital computers in operation throughout the country. Many of these are available on a per-hour rental basis and there are quite a few now operated by competent Service Bureaus. There is no need for a practicing engineer or technician not to make use of this powerful new tool as the occasion demands. It only requires several days' training to learn how to make use of the facilities, and there are installations available for use practically anywhere.

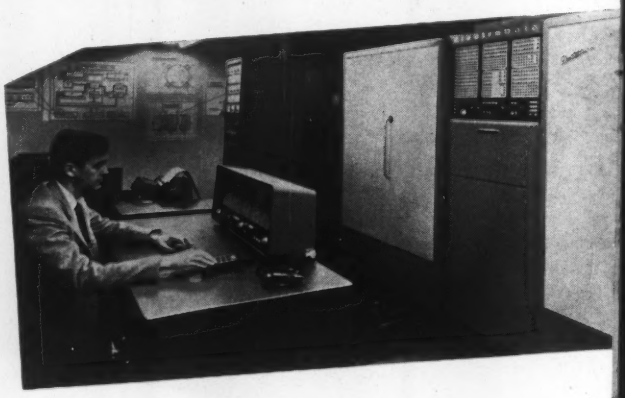
Many types of engineering problems are peculiarly adaptable to digital-computer handling. The gain in accuracy and in time spent is most rewarding and offers much promise for the continued development of our various individual fields of interest.

### Freeing Skilled Talent

Enough experience has now been acquired to make certain generalizations and conclusions as to the importance of electronic computers to the engineering professions. Computers have solved many problems that would have been too large for any other method of solution. Computers are, at an increasing rate, taking over the burden of repetitive computations and are thus freeing skilled talent for more creative work.

The United States Steel Corporation stated in its January, 1958, company magazine that its computers

**ELECTRODATA** **In Dallas, this Datatron 205, installed in 1955, processes data for Magnolia Petroleum**



[1] Condensed from "The Use of Digital Computers for Petroleum and Refining Engineering Problems," by R. J. Baxter, Gulf Oil Corporation, Pittsburgh, Pa. ASME Paper No. 58—Pet-24.

For instructions in ordering pamphlet copies of original papers see order form in the Technical Digest, this issue.

saved an estimated 100,000 engineering man-hours in 1957, and management felt they were "just scratching the surface." In creating a new position of "engineer-electronics," the vice-president of engineering stated: "The way is now clear for all of us to reach the goals of a more refined conclusion, a more accurate result, a quicker solution, less time, and less effort expended."

(The author then presents nine pages listing engineering applications of the electronic computer in the petroleum industry. Under the main head of "Production Department," there are 12 subheads: Exploration, Drilling and Completion, Production Engineering Data on Punch Cards, Field Performance and Reserves, Gas Plant Processes, Oil and Gas Field Operating Problems, Data Reducing and Handling, Mathematical, Economic Studies, Operations Analysis, Mechanical Design, and Gulf Research & Development Company Computer Section.)

# Technical **CALCULATIONS**[2]

As REPORTED in the press,[3] by January, 1958, there were 76 medium-sized computers and eight large-scale computers installed in the petroleum industry.

As the sizes of the computing problems increase, they increase not in an additive way, but by multiples. The reason is that expansion of a problem statement usually takes place by adding another variable or studying another parameter. In other words, expansion to a larger problem is by adding an additional degree of freedom. So, if the engineer wishes to study five cases of variation for an additional variable, he may be required to perform five times as many computing operations. Thus the need for larger and faster computers keeps increasing.

Technical computer usage in the petroleum industry can be broken down into three major divisions: exploration and production, refining, and transportation and marketing.

Each of these divisions will have its own problems and objectives, but the single over-riding objective is that of increased revenue for the company. While a number of oil and gas companies have been using computers for several years, the companies starting are not too far behind; the surface has only been scratched.

### Exploration and Production

In exploration and production, the major objectives are: better methods of finding oil, and increased recovery. In both cases, partial solutions have been found. Often, the solutions involve enormous amounts of computation. However, this is worth doing.

In a paper by Bruce,[4] the general concepts of what promises to be a very fruitful attempt to further the solution to the first objective—better methods of finding oil—are outlined. This is in the application of operations-research techniques to aid in the necessary management decisions in determining company policy in the exploration area. Here is where the largest amount of money is to be made by any oil and gas company by using computers.

A number of petroleum firms are using the computer for the interpretation of the results of gravimetric and magnetic surveys, in the adjustment of gravity networks, in wave-front calculations, and in the correlation of stratigraphic data.

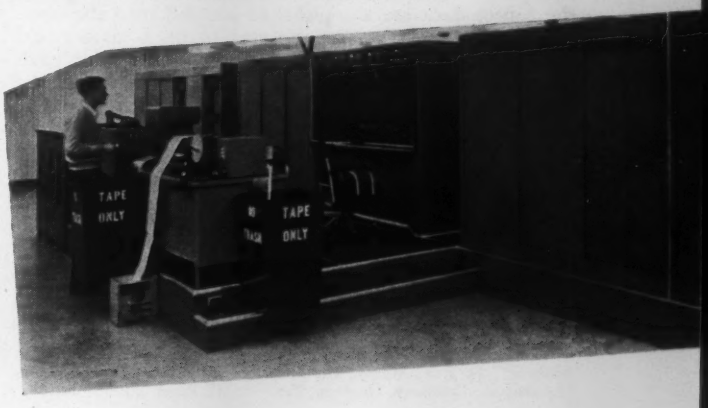
For technical calculations, computers are finding increased usage because the engineer is able to eliminate some of the simplifying assumptions he found necessary when using desk calculators. But, probably more important, the engineer is able to study the results of a reservoir prediction while varying all of the variables over a wide range. In this way, he is not tied down to one prediction at only one set of values for the variables, but is able to re-evaluate his interpretation of the results based on any new reservoir information. He is also using the computer as a learning device or a research tool.

A starting point for most oil companies applying a digital computer to their reservoir problems is to write programs to predict the recovery of oil from a reservoir. This may be accomplished by using any one of several different equations, such as Muskat's, Tarner's, or Schilthuis'.

Lately, there has been increased interest in predicting the recovery of oil by combining equilibrium flash calculations with a material balance and the fluid-flow equations. The latter approach provides much more information, such as composition and density of the producing steam, as well as the reservoir material. These data will allow better design of the surface facilities, which is an important by-product of any reservoir study. The one inherent inaccuracy in these calculations is the equilibrium ratios. Again, the computer can be used as a research tool by the practicing engineer by using it to improve the available equilibrium ratio correlations.

A number of companies in the oil and gas industry

**UNIVAC** **At SMU, this Remington Rand computer solves problems of oil exploration and refinery operation**




[2] Condensed from "Use of Digital Computers for Technical Calculations in the Oil and Gas Industry," by W. S. Pickrell, International Business Machines Company, New York, N. Y. ASME Paper No. 58—Pet-27.

[3] *Petroleum Week*, Sept. 27, 1957, p. 44.

[4] W. A. Bruce, "Use of High-Speed Computers for Petroleum Problems," presented at IBM Petroleum Seminar, Endicott, N. Y., October, 1956.

are computing the optimum separator pressures for multistage surface separation equipment. The program can be written so as to maximize the tank oil produced or the sales gas; however, better still, would be to maximize the total revenue from both tank oil and sales gas.

Three of the major oil companies, using the IBM 704, are solving the basic partial differential equations to develop optimal flood patterns for proposed waterflood projects, primary depletion predictions, optimum well spacing, and the effect of offset wells. These problems require the fastest and largest computers available; however, the pay-out potential is great. In a large oil field, increasing the recoverable reserves by only 2 to 5 per cent will pay for a large-scale computer.

### Refining

The use of computers in refineries is well in advance of that in other areas of the oil and gas companies. This is probably because their problems are better defined than those in other departments.

Most refiners feel that economic and optimization studies will be the most profitable for them. There are two main techniques used: linear programming, and case study or simulation studies. Linear programming models are being used in all phases of refining. The only requirements for your economic model to be solved by the use of linear programming is that the restraints on the system must be a set of linear equations and to have a linear profit function which is to be maximized. These requirements are common in many phases of the refining business. The following are some of the problems being solved, using linear programming:

***Gasoline Blending.*** In this application, savings of up to 2 cents a barrel have been realized by some of the refiners. These savings result from decreased quality give-away and from additional economic information which is the output from running such a problem on the computer.

***Crude Evaluation.*** The set of optimum crudes to run to the refinery may be determined based on cut points and gasoline blending stocks required.

***Solvent Scheduling.*** In refineries where a large number of solvents are manufactured, a more efficient scheduling of the solvent units results from optimizing the operation using linear programming.

### Transportation and Marketing

In transportation, pipeline scheduling is being undertaken. One interesting application is the determination of tankage requirements. One tankage system which has been studied had an input from pipeline and output either to the refinery or via coastal tankers to other refineries. However, the crude arrived in varying quantities about a long-range purchase amount. The refinery pipe still varied, subject to down time, and the arrival of tankers fluctuated. A meaningful solution was obtained, however, using standard Monte Carlo methods on the refinery's computer.

Several companies have done computer work on vibration studies in gas compressor stations. Actually, some companies have advanced the use of computers to the extent of having almost completely mechanized compressor-station design.

In marketing, computer methods have been developed which involve correlation analysis to determine such facts as the desirable location of retail gasoline stations in new marketing areas. Transportation and marketing studies are adaptable to the linear-programming method of solution. Some of the companies have extensive plans in undertaking extremely large studies in this area.

## Compressor Stations—**ANALYSIS**[5]

OPERATING-MANAGEMENT control of the performance and maintenance of over 500 compressor engines has been made more effective through the use of a medium-sized electronic computer at Tennessee Gas Transmission Company. From the daily compressor station reports, the source data are key-punched and fed into the computer along with a large volume of fixed master-card data to produce a computed report, listing for each engine the horsepower-hours, calculated volume, oil use, repairs, and various operating conditions. The different types of compressor engines may now be compared according to their loading conditions, compressing ability, and their parts usage.

The company compressor stations have one to three buildings with as many as 15 engines per building. The main compressor engines generally run from 1000 to 2000 hp.

Before inauguration of the computed daily compressor reports, a machine-computed performance curve and operating curve were made for each type of engine at the stations. Basic compressor cylinder data were supplied.

**IBM** **The IBM has been called the work horse of electronic data processing, for both commerce and science**

[5] Condensed from "The Electronic Computer and Compressor Station Analysis," by J. T. Manry, III, Assoc. Mem. ASME, Tennessee Gas Transmission Company, Houston, Tex. ASME Paper No. 58—Pet-29.

By computing the swept volume and using a compressor formula, the program produced all the points necessary to plot the performance curves and the operating curves. The operating curves are used by the station operators to load the engines to capacity as necessary.

### Compressor-Station Summary

The computed daily compressor-station summary is tabulated on a printed form for each station. Information about the operation of each engine is listed. At a glance, comparisons may be made between the engines.

If you were reviewing the report of a compressor station that was known to be operating at full capacity, then you might at first be interested in the hours that each engine ran, and the horsepower that each engine developed.

On the lower part of this daily compressor-station summary, the oil is summarized for the engines, the auxiliary engines, the other station usage, and the reclaimed oil. Also summarized are the station horsepower hours and the calculated throughput. The average station horsepower is arrived at by adding up a computed developed horsepower for each engine. The dispatcher's throughput is printed out and used to calculate the station efficiency by dividing it by the calculated throughput.

You may already be thinking about the possibility of the operator writing down favorable numbers to influence station efficiency. By running engines at a faster rpm than that recorded would make the efficiency number higher. By showing more pockets open than actually are open on the engine would raise the number of the station efficiency. These same numbers that would increase the station efficiency by erroneous entry would show a smaller developed horsepower than that the engine is actually running. When it was noted that the developed horsepower was not up to par, a check of the compressor operating curves would show that the unloader pocket was set for the proper loading, especially during the period that the station was expected to give maximum performance.

The monthly compressor-station summary is mostly a totaling and averaging of the daily compressor-station summary figures plus some year-to-date figures brought forward. For each engine the listing is made of the hours operated, the hours operated year-to-date, horsepower hours operated this month and year-to-date, oil-consumption rates in quarts per 24 hr for the cylinders, crank case, and compressor cylinders. Also listed are total oil used this month and year to date, horsepower hours per gallon this month and year to date, the average rpm, rated horsepower, and the developed average horsepower.

### Compressor-Efficiency Report

The next computed report is the monthly report of compressor efficiencies. The numbers on this report are identical to those found on the monthly compressor-station summary. This report simply lists all the stations, showing their average efficiency for the month, permitting comparisons between the current month and the previous months. Any trend downward on any particular station would make it worth while to investigate the cause and if possible get the trend reversed.

An engine repair analysis report is prepared monthly for each compressor station. To produce it the maintenance and repair record sheets are processed monthly. A normal run consists of listing all repairs for a station by repair categories and subcategories in engine number order. The time spent for each repair is summarized within the subcategories by engine type.

For special studies, comparisons may be made between repairs by engines, engine types, stations, categories, subcategories, and engine manufacturers. It should be possible to determine the most serviceable spark plug for a given type of engine simply by comparing quantities used for each manufacturer over a certain length of time. Engines using the most pistons would be a worth-while examination, along with the quantity of rings used on the various engines and engine types.

### Engine Availability

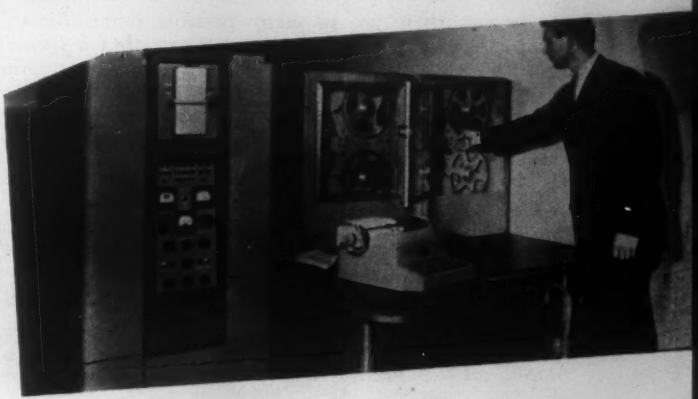
The engine-availability and down-time report is shown by stations, and for each engine is printed its engine type, the total down time of all categories, total repair down time, the total unavailable time, the repair time per million hp hr, per cent operated, per cent availability, and the load factor.

To make any complete repair analysis for a particular engine part, the per cent load factor would be a big consideration. For instance, the ring wear of an engine running at 98 per cent load factor would be somewhat different from an engine running at the 75 per cent load factor. It is hoped in time to be able to determine the optimum load factor for the best service of such large engine parts as crankshafts, power cylinders, and pistons.

The big plus factor of electronic computer reports has been to increase greatly our knowledge of the operation and maintenance of compressor equipment. Information that was previously obtained by sampling, is now processed on a daily basis. Monthly reports that used to be verified and balanced by comptometer operators need not be checked after once being processed through the computer system.

There is some difficulty experienced in writing the rules for the operators and repairmen to code the engine repairs properly. Much research should be given to any system of coding repairs and down time. The more

**BENDIX** The G-15 General Purpose Computer, with its control typewriter and tape units for additional memory storage



categories and subcategories that your coding can be broken down into, the more your computer reports can tell you. However, the more coding that has to be done by the field maintenance men, the more the chance of errors, causing reruns.

There exist many possibilities. Some day answers may be found for some of the following:

Optimum time for renewal of crankshafts after so many hp hr of engine operation.

Ideal quantities of items stocked in station warehouses.

Optimum location for large expensive compressor parts.

Most efficient combination for engines to run at a given station location.

Optimum location for expensive compressor parts.

# Natural-Gas Systems—DESIGN[6]

THIS PAPER presents a method for determining the pressure distribution in a natural-gas gathering system using a high-speed digital computer and the Hardy Cross iterative technique.

The use of the computer in solving this problem has now been proved practical and can be considered a common engineering-department procedure rather than a developing technique in research.

A natural-gas-field gathering system consists of the network of pipelines which collect gas from individual wells in a natural-gas field and transport the gas to one or possibly to several central points for delivery to a main-line transmission system. Gas wells are usually placed one on each 640 acres; the field served by a gathering system may include several hundred wells. Field compressors are an integral part of the system, and are used to boost the gas through the pipelines, where necessary.

The network can consist of an almost infinite combination of arrangements of locations or routes. These can all be resolved into individual well lines, branch or spur lines, and looped circuits. A loop as used in this paper means a tie-over between branch lines, and not a parallel line to branch, as is commonly intended.

A looped circuit is seldom installed as original construction. Frequently, as a gas field develops in unexpected directions, or as certain wells fail to fulfill earlier expectations, a loop circuit is a very economical improvement to an existing system.

### The Design Problem

Because there are so many possible routes for the parts of a gathering system, it appears that a specific design technique cannot be developed. Therefore the problem of design resolves into a study of cases. A trial network design is laid out, the pressure distribution is evaluated, compressor facilities are selected, and finally the cost of service is estimated. The entire process is repeated for another trial design and another, until the designer achieves a "satisfactory" plan.

The problem of determining the pressure distribution is straightforward enough in a simple branched lateral system. In a network involving several loops, tedious trial-and-error or iterative techniques are required. It has been found that a partly looped system serving about 200 wells requires approximately one man-week to fix the pressure distribution. Thus only rarely has the "study of cases" for the entire field been carried beyond a few trials, and therefore it has often happened that a better plan could have been devised.

By use of high-speed computing machines, the pressure-distribution problem can be solved in a few minutes; it has been found that a 200-well design can be reduced to punched cards, processed through the computer, and the results interpreted in 4 hours. Thus the designer can investigate a large number of variations.

### Network of Loops

The analysis described in this paper is based on the Panhandle Eastern Pipeline Company flow formula. The solution of a loop system is based on the iterative method developed by Hardy Cross. The method relies on Kirchhoff's laws of networks; the net flow at a junction is zero; the algebraic sum of friction drops around a closed circuit is zero. A flow pattern is assumed in each loop, with the restriction that the inflow to any junction must equal the outflow.

On the IBM 650 without additional storage, there is room for instructions and data for a system of 498 sections in up to 46 loops. This is more than adequate.

**CONSOLE** The girl is shown checking out ("debugging") a program at console of SMU's Univac 1103

[6] Condensed from "Evaluation of Natural-Gas Gathering System Design With an Electronic Computer," by L. R. Henry, Assoc. Mem. ASME, and R. B. Peritz, both of Colorado Interstate Gas Company, Colorado Springs, Colo. ASME Paper No. 58—Pet-28.

The spur system input consists of physical data for each section and the volume. At junctions of minor spurs, the volume of the minor spur is summed from its wells to become a source for the major lateral. The output lists for each section its identification, flow, $\Delta P^2$, and $\Sigma\Delta P^2$ from the first section.

The input data for the loop systems consist of physical information for each section, and an assumed initial flow distribution. The output data include the correct flow through each section, and $\Delta P^2$ and $\Delta P^2$ per mile for the section.

The gas volumes and wellhead pressures are used as input data for well line calculations, along with physical data for each well line. The machine computes $\Delta P^2$, $\Delta P^2$ per mile and terminal pressure for each line, and prints out results.

The absolute pressures at the compressor-station inlet are determined by summing the $\Delta P^2$ for the sections between the station and each of the well inputs. One of these will be least; it is the station inlet pressure.

### Conclusion

The method is applicable to the evaluation of either a new design or of improvements to an existing design.

By means of this machine evaluation, the designer can evaluate more variations and therefore can usually provide a more economic design.

### Bibliography


Hardy Cross, "Analysis of Flow in Networks of Conduits or Conductors," Bulletin 286, University of Illinois Enginering Experiment Station, Urbana, Ill., 1936.

R. D. Sickafoose, "A Punched Card Program for Calculating Gas Distribution Network Pressure by the Hardy Cross Method," IBM Reference Manual—Electronic Computer Engineering Applications, Public Utilities, Gas, IBM Corporation, 1957.

S. Togasaki, "Gas Network Analysis," IBM Reference Manual—Electronic Computer Engineering Applications, Public Utilities, Gas IBM Corporation, 1957.

R. B. Peritz, "Looped Gathering System Design," IBM Electronic Data Processing Seminar, Dallas, Tex., May 27, 1958.


# Pipeline Investment—**Analysis**[7]

NEW discoveries of oil deposits call for investment analyses for new pipeline facilities. This paper reports on the use of electronic computation by a crude-oil pipeline company.

The problem is complicated, in that the origin and destination of the proposed pipeline are not always known prior to economic study. A single oil discovery is often followed by subsequent discoveries in adjacent localities. It is usually possible for the geologist to indicate the regional extent of such possible future discoveries. This information must be considered, as it is desirable to maximize the likelihood of economic service for possible later discoveries. This situation leads to the study of alternative "origins" for the pipeline. Similarly, the destination of the pipeline may be subject to question as the profitability of crude delivered to different refining centers varies.

In a representative pipeline system, there will be multiple points of crude receipt (oil fields) and multiple destinations. Variation will usually occur in line diameter and unit costs in segments of the system.

Aside from the origin and destination of the proposed line, the primary variable is the amount of oil to be pumped through the line. The anticipated line throughput is basic to the economy of the line as it determines the size of line required and the revenue to be generated.

### The Unknown Factors

In addition to various possible assumptions regarding throughput, assumptions must be made for unit costs of construction and operation, line route, crude physical properties, property-tax rate, interest rate for borrowed capital, amount and repayment schedule for borrowed capital, and for other parameters.

An analysis of a proposed pipeline usually will include the basic design of the line, estimation of the capital and annual operating costs for the system, and computation of critical financial data for the project. Financial data of principal interest are capital outlay, cash return, pay-out period, and yield on investment. It is often desirable to compute the data for each year of the projected life of the proposed line.

As the computations outlined demand weeks of manual labor, the stored program computer has been used to shorten the study time. A number of programs have been written for the computer to handle different portions of the computation. Basically, the work is divided into pipeline design, capital and annual operating-cost estimates, and financial computation. Wherever practicable, the output from one program is coupled with the subsequent program by common punched-card format.

Normal input to the design program includes a physical description of the proposed pipeline in terms of length, terminal elevations, assumed diameter, crude

**MEMORY** **Inside the IBM 650 magnetic drum. Data (to 20,000 digits) are stored in the form of magnetic spots**

[7] Condensed from "Computational Analysis of Pipeline Investment," by T. R. Young, Shell Pipe Line Corporation, Houston, Tex. ASME Paper No. 58—Pet-26.

properties, and range of line throughput values. In addition, values for pump and motor efficiencies, maximum permissible line pressure, and spare power are also read by the computer.

Output data are the number of pumping stations required in each segment of the system and the required power per station at each throughput level.

In a multi-year study, pumping stations will be added as line throughput increases over the years. The original installation will then be so planned that it will become part of the final layout in such a way that there will be no excess stations at ultimate capacity.

### Capital Estimate

Completion of the hydraulic calculation yielding required number of stations and power per station completes the data required for estimating the capital investment for construction of the proposed pipeline.

Other required data include unit costs for pipeline installation, pump station construction, communications, river crossings, tankage, terminals, and other miscellaneous costs.

The capital estimate is built up from two classes of expenditures: arbitrary expenditures which are unrelated computationally to any other available data in the computer, and expenditures which are computable as extensions of unit costs multiplied by suitable bases. Bases used in this way include line throughput, power required per station, line length, and number of pumping stations. Arbitrary capital costs are represented by costs for terminal facilities, waterside facilities, and river crossings. In general, the latter are special costs which require independent estimate based on engineering evaluation of the construction involved.

Design practice will usually vary depending upon the size of a pumping station, and it is necessary to select proper unit costs to represent the particular design practice. In the case of pumping stations the cost is estimated as a base plus a unit cost per horsepower installed.

### Operating Cost

Annual operating expense is estimated in a similar manner. Again, two classes of expense are recognized: arbitrary costs that require independent engineering estimate, and those costs related to assumed or previously computed parameters of the system, such as power, throughput, investment, line length, or number of stations.

The same problem of variable unit costs occurs here. As an example, station maintenance expense is estimated as a decimal fraction of station investment up to an arbitrary investment level at which point a smaller decimal fraction applies to all additional investment.

Cost elements recognized in the annual operating-cost estimate are: station maintenance, fixed-station operation, terminal operation, tank-farm operation, pipeline maintenance, communication maintenance, oil loss, pumping power, miscellaneous, and administrative overhead.

(Here, and elsewhere in this paper, the author presents estimating equations. The nomenclature lists symbols for more than 50 variables. The paper also includes charts, graphs, and tables showing typical results of computer analysis.)

In the first applications of the electronic computer to capital and operating-cost estimation a nearly exact duplication of the usual manual procedure was programmed. As a consequence, the programs so developed were specific for a particular style of estimate preparation. However, it has been observed that a program can be advantageously generalized by providing an assortment of estimating bases. These provide flexibility in the method of estimate itself. To illustrate, pipeline maintenance may be satisfactorily estimated by a unit cost per mile of length or by use of a unit cost per dollar of investment. It is done both ways. In order to be prepared for either mode of estimation, the program should contain the arithmetic in both calculations.

This type of generalized programming achieves two goals: it gives the engineering economist a choice of estimating procedures, and it increases the probability that the estimating procedure used by a separate engineering organization may be duplicated with the existing program. This is particularly important in the case of intercompany economic study of proposed joint ventures where a common estimating procedure is determined by negotiation.

Programs of the sort described in this paper have been employed in economic studies of three major construction projects with total valuation approximating $80 million.

In addition to major projects, other studies have been made dealing with investment planning for gathering and truck-line expansion. In addition, general economic studies dealing with optimum pump-station spacing and tariff policy are being carried out.

The computation work reported has been carried out using a basic IBM 650 digital computer with a utilization of about 30 per cent of single-shift operation time. The balance of the computer availability was used by other activities within the organization.

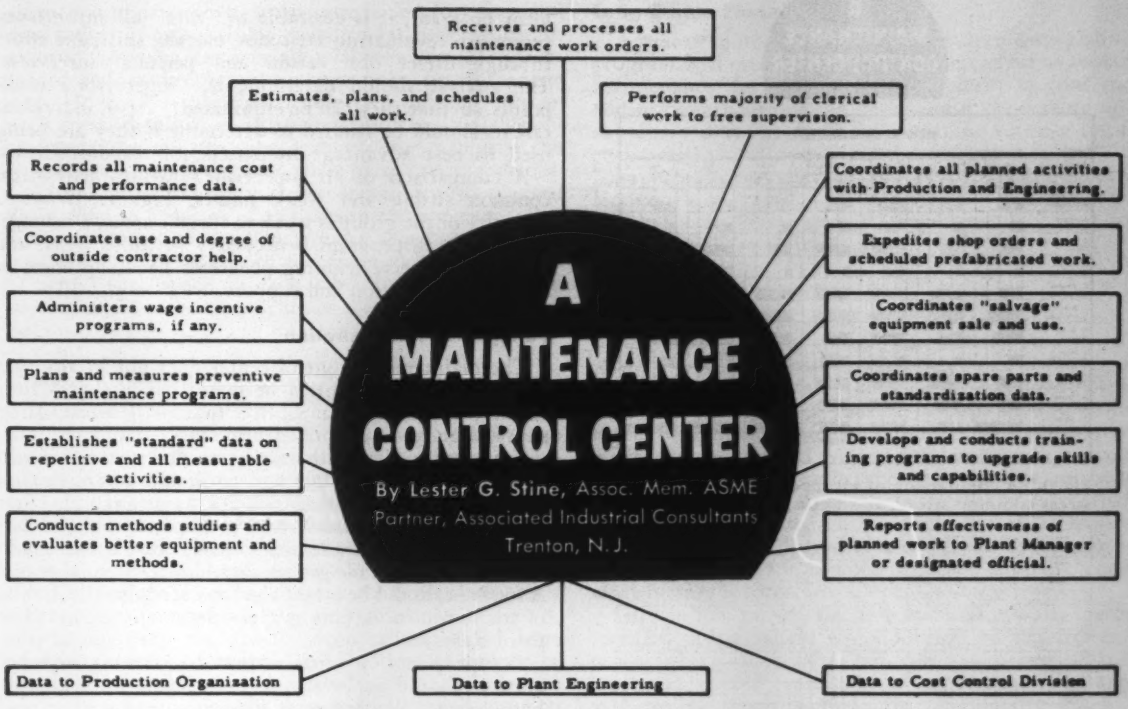
### Equipment, Methods, and Staff

Systems used for programming include an assembler, an interpreter, and a compiler. These are the IBM Symbolic Optimum Assembly Program (SOAP II), the Bell Laboratories Interpreter, and the Purdue Compiler (IT), respectively. All three systems have proved valuable and are selected according to the problem.

The staff handling the work consists of three full-time members, an engineer, a mathematician, and a programmer, with supplemental work by outside personnel.

### Acknowledgments

The author wishes to express appreciation to Mr. Robert Barton, Shell Oil Company, for long continued instruction and counsel in the application of automatic computing techniques; to Mr. Gerard Guyod, Shell Oil Company, for inventive and invaluable programming aid; and to Mrs. Sara Coate, Shell Pipe Line Company, for great assistance in the use of the program. ●


Receives and processes all maintenance work orders.
Estimates, plans, and schedules all work.
Performs majority of clerical work to free supervision.
Records all maintenance cost and performance data.
Coordinates all planned activities with Production and Engineering.
Coordinates use and degree of outside contractor help.
Expedites shop orders and scheduled prefabricated work.
Administers wage incentive programs, if any.
Coordinates "salvage" equipment sale and use.
Plans and measures preventive maintenance programs.
Coordinates spare parts and standardization data.
Establishes "standard" data on repetitive and all measurable activities.
Develops and conducts training programs to upgrade skills and capabilities.
Conducts methods studies and evaluates better equipment and methods.
Reports effectiveness of planned work to Plant Manager or designated official.
A MAINTENANCE CONTROL CENTER
By Lester G. Stine, Assoc. Mem. ASME
Partner, Associated Industrial Consultants
Trenton, N.J.
Data to Production Organization
Data to Plant Engineering
Data to Cost Control Division

*The control center offers to maintenance what industrial engineering and production control give to production. It should be responsible for where, when, and what maintenance work is done—and be organizationally neutral.*

IN TODAY'S fast-moving automated industry, plant maintenance, with its ever-increasing cost, is a subject of critical concern. Unlike direct production operations, maintenance is difficult to measure and, in the past, few systems have been devised that will really control maintenance cost.

## A New Approach

A new approach, the "maintenance-control-center" technique, integrates planning with labor measurement and emphasizes the co-ordination of all maintenance activities. Procedures are specifically directed at uncovering opportunities for labor-cost reduction. Established goals of performance are constantly refined, and improvement is almost automatic.

This technique has been installed in several large pulp and paper mills, resulting in improved maintenance service, less down time on machinery, and reduced labor cost. A maintenance man-hour reduction of 40 per cent whose value exceeded $200,000 per yr was achieved.

The development of a maintenance-control-center program should start with a re-evaluation of the over-all maintenance function and exploration of all potential areas for improvement. One phase cannot be improved without developing another related phase if lasting results are to be achieved. Individual job standards, for example, are not practical for hourly men unless foremen and supervisors are trained in the value of planning and scheduling all work.

## Control-Center Concept

The control center is physically an organizational group which is to maintenance what industrial engineering and production control are to production.

Lack of planning, poor co-ordination, and other interferences rarely result in a rating of over 60 per cent in over-all effectiveness for maintenance men although they generally work at a good pace when busy. The control center places emphasis on these particular areas—organization, planning, scheduling, and assignment.

Another important factor in the organization and planning of maintenance work is the co-ordination of "what is desired" with "what is required" to do the job. Emergency service interrupts planned work and contributes greatly to the inefficient use of maintenance labor. "Gold-plated" maintenance, where considerably more labor is used than is required, is another contributing factor. This usually results when maintenance supervisors want to be "safe" and carry extra labor for peak-load conditions.

The control center uses the same approach in the performance of its activities as industrial engineering. Where industrial engineering uses time study to arrive at a job standard, maintenance control will gather data

Contributed by the Maintenance and Plant Engineering Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 58—A-269.

A MAINTENANCE CONTROL CENTER

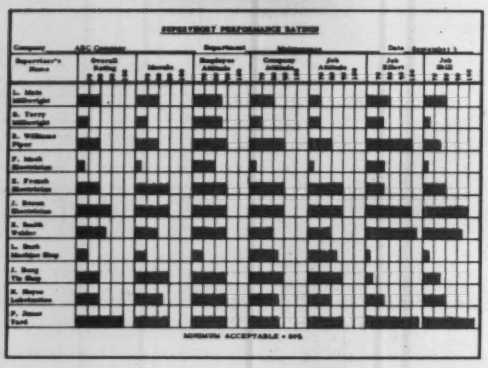


Fig. 1 A comparison of all supervisory ratings will stress common strong and weak points

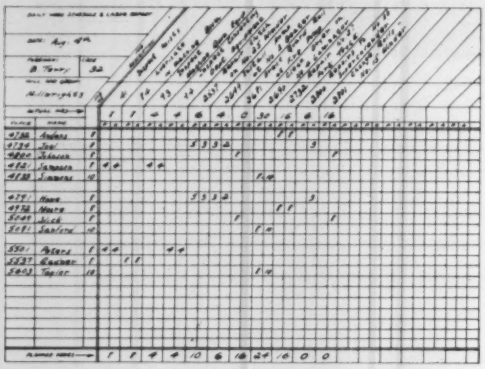


Fig. 2 The work schedule and labor report is used for planning and collecting the actual time spent

and statistics, which are merged with the maintenance foreman's experience, to arrive at a job standard. This form of measurement can be particularly effective where there is a high degree of nonrepetitive work.

### Organization

To be most effective and unbiased in its thinking, the maintenance control center should be organizationally neutral to the groups for which it co-ordinates, plans, schedules, and measures work. Its members should not report to production, nor can they be objectively critical of maintenance if they report to maintenance. Ideally, a service manager, or other neutral administration within a company organization, will provide the best source of over-all direction. If this service manager also has production-control responsibilities, the co-ordination of shutdown planning is simplified. An interrelationship with industrial engineering also adds to effectiveness.

To use skills properly and provide the best coverage, the control center should be responsible for where, when, and what maintenance work is to be done, while maintenance supervision retains responsibility for why and how it is done.

A key factor in any organization is the effectiveness of its personnel. In an over-all maintenance-improvement program, it is desirable to "rate" all supervisory personnel—evaluating attitudes, morale, skill, and effort through direct observation and personal interview. The analyst should determine the supervisor's weak points so that they can be eliminated. Also, individual talents should be studied to determine if they are being used to best advantage in present job responsibilities.

A comparison of all supervisor's ratings will stress common strong and weak points, Fig. 1. When a majority of the group is weak in specific areas, a management training program is necessary in those areas, and the most effective training programs have top management's participation and support.

### Policy and Administration

The maintenance control center does not in any way usurp the responsibilities of maintenance supervision. Rather, it provides a service that will assist direct supervision to do a more effective job.

Company policy with respect to maintenance should be studied to insure fair and equitable administration of salary and promotion policies. For example, first-line supervisors should earn 15 to 20 per cent above their average first-class tradesmen. And, comparable grades within different trade groups should receive equal wages. A formula should be established to determine the number of tradesmen in varying grades—first-class, second-class, third-class, and so on.

Company policy with respect to training and promotion should include a formal means of evaluating knowledge. Written tests for promotion within trade groups, standard merit-rating procedures, and similar methods are particularly important today when it is desirable to prove that qualifications override seniority in job promotions.

### Planning Procedure

A formal procedure for planning, scheduling, and co-ordinating work is essential to maintenance efficiency. The control center accomplishes this with a "job-control procedure" that is designed to fit the needs of the individual company. Basically, the control center (*a*) justifies the need for the job; (*b*) plans and co-ordinates with production, engineering, and maintenance as required; (*c*) assists maintenance supervision in establishing work schedules, including time estimates for labor; (*d*) collects actual labor time and job costs for accounting distribution and management analysis; and (*e*) compares actual performance with planned performance and makes recommendations for improvement.

Written work orders are essential. Verbal orders cause confusion and misinterpretation in both production and maintenance departments. A primary concern is to get the correct information to the mechanic who will do the job. A serialized job number codes and simplifies later cost procedures. Work orders are reviewed for material availability, proper instructions, methods, and sound engineering principles, and are studied in relation to the economy and real necessity of doing the job, or the cost and desirability of using outside labor or fabricated parts. Finally, the control center estimates the number of men and man-hours required for the work order and schedules the job.

### Daily Planning

Daily work planning in meetings with the supervisors

of each craft is essential both in reducing lost time and as a means of establishing goals for labor performance. Priority is given to over-all mill production requirements and to keeping the crews busy for the entire day. It is advisable to schedule two or three men in each crew for fill-in work so they will be available for emergency-breakdown jobs if they occur. Repairs can be made on spare equipment, spare parts can be replaced.

Actual daily time should be compared with planned daily time as a means of evaluating performance. One convenient method is a "daily work schedule and labor report," Fig. 2, used both for planning and collection of actual time spent on each job. In addition, it can be used as a source document for accounting cost distribution.

## Shutdown Planning

Shutdown planning should be co-ordinated to insure that machinery down time, which can be worth $500 an hour in some industries, is held to a minimum. This is an area where the maintenance control center can be used most effectively. Shutdown co-ordinating meetings held with production, maintenance, and engineering personnel determine and agree upon (*a*) the details of the work to be done, and (*b*) how long it should take.

Following the meeting, the control center prepares a Gantt chart "shutdown-planning schedule," Fig. 3, which identifies the specific jobs, the planned time schedule, crew assignments, and the specific men to be assigned to each job. This schedule is then used to assign men and is usually posted in a central location where the work is being done. It is also used to follow each job and record actual time. The control center co-ordinates each working group, through group supervision, to insure that the schedule is followed and down time is held to a minimum. Shutdown performance is evaluated and methods for improvement recommended.

## Long-Range Planning

A year or more of operation of the shutdown-planning program will establish a definite trend as far as required maintenance for production equipment is concerned, and recommendations can be made for the setting up of shutdown dates as much as a year in advance for the entire mill. Shutdowns can be staggered to have the least effect on production and to permit the most effective use of maintenance manpower. Equipment will always be in better over-all condition and will consistently yield more production.

## Methods Improvement

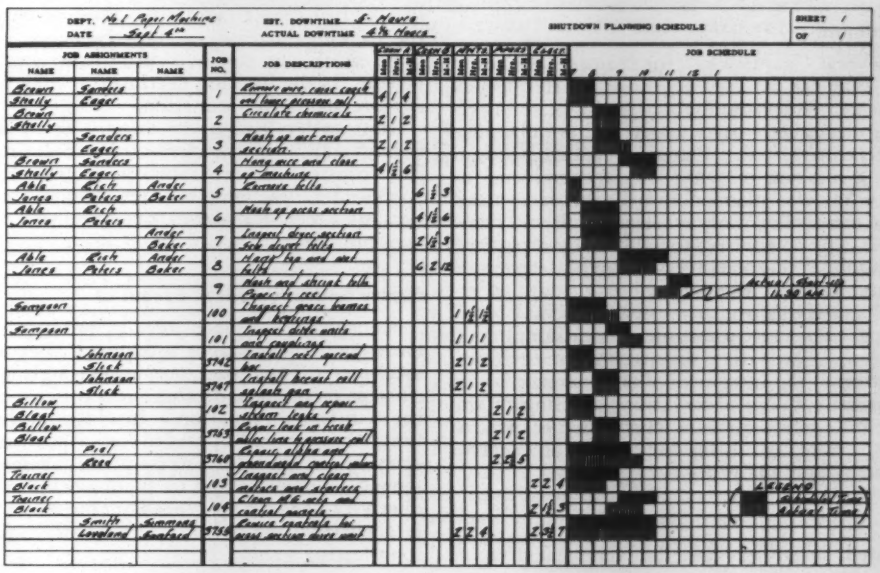
Objective analysis of all methods used will lead to better ways of doing things, particularly on repetitive jobs. Preventive maintenance, through routine inspection procedures, can usually reduce emergency breakdowns. A program of routine inspections and adjustments to equipment can be established through contacts with manufacturers as well as maintenance supervisors. Inspection cards for each type of equipment are issued regularly and used as check lists for the inspections. Adjustments are noted on the cards as well as requests for future work, and they serve as a basis for making out work orders and for posting pertinent data to "equipment-history records."

Lubrication procedures and methods usually permit standardization. Reviews of lubrication requirements, proper check lists, and the effective usage of oiler personnel, or the evaluation of the economies of automatic oiling versus manual labor offer opportunities.

Improved maintenance service and/or cost reduction through the evaluation of new maintenance tools and equipment should assist maintenance supervision and be the justification for maintenance capital investments.

Many times, maintenance shops are located in obscure plant areas not required for production, with little

**Fig. 3 The shutdown-planning schedule identifies the specific jobs, the planned time schedule, crew assignments, and the specific men who will be assigned to each job. It is the basis of planning, assignment, and follow-up.**



A MAINTENANCE CONTROL CENTER

I BACKLOG STATUS

| Trade | Incomplete At Start of Week | Number Completed | Number Opened | Incomplete At End of Week | Change |
|---|---|---|---|---|---|
| Mechanics<br>Welders | | | | | |
| Carpenters<br>Cement Makers<br>Masons<br>Painters | | | | | |
| Machinists<br>Blacksmith<br>Molder<br>Ball Grinder | | | | | |
| Pipefitters | | | | | |
| Elect. Maint. | | | | | |
| Elect. Const. | | | | | |
| Mechanical Const. | | | | | |
| TOTAL | | | | | |

II ANALYSIS OF BACK ORDERS UNASSIGNED

| Age | Waiting For: Material | P. M. Shutdown | Other Shutdown | Trade Time | Other | Reason For | Total | % |
|---|---|---|---|---|---|---|---|---|
| 0 - 1 Week | | | | | | | | |
| 1 - 2 Weeks | | | | | | | | |
| 2 - 3 Weeks | | | | | | | | |
| Over 3 Weeks | | | | | | | | |

III OPENED ORDERS - PRIORITY REQUESTS

Fig. 4 A control on backlog is maintained with the work-order report

thought given to the efficiency of maintenance people. Organization of the physical facilities of maintenance to reduce travel time is a definite part of an over-all program. Shops should be in one central location, close to production, to minimize handling and lost time. The maintenance control center should be centralized to improve communications. The cost-reduction potential of consolidating or reorganizing the maintenance layout should not be overlooked.

### Work Measurement

There are several "yardsticks" for maintenance work measurement that can be used to show relative trends and improvement. A continuing analysis of planning effectiveness is desirable, particularly when planning techniques are emphasized. Planning effectiveness can be defined as a measure of what was accomplished as compared to what was planned and can be determined daily with the use of the "daily work schedule and labor report," Fig. 2. By comparing actual hours and planned hours for each job, a weighted average can be determined for all jobs, and for each foreman each day.

Labor productivity is another essential "yardstick" of maintenance. For most companies, work sampling is the best method. Basically, this technique involves: First, a definition of the categories of maintenance labor; then, a statistically sound observation sampling of the work to determine relatively how much time is spent in each category. Here, again, the bar chart is an effective way of presenting and analyzing data.

### Incentives

Properly used incentives can be very effective in maintenance-labor cost reduction. Like production incentives, they should be used only after the best methods for doing work have been established. Programs must be tailored to the particular needs of a particular company, and although there is no general pattern or standard approach, it is usually desirable to develop a number of factors that are a measure of productivity and that are within the control of the men on incentive. Each factor should be evaluated in detail and weighed properly in relation to other factors. The control center can conveniently administer an incentive plan, as measurement is one of their basic responsibilities.

### Cost Control

Accurate and effective cost analysis is the key to successful maintenance cost control. A good cost system must be able to pinpoint cost responsibility and indicate areas which require management emphasis. One approach, which has proved successful with maintenance cost is: (*a*) Establish a code system for cost-distribution analysis—codes should be selected on the basis of defining the factors which control cost; (*b*) install convenient methods for accurately coding both labor and material charges as they occur—a job-cost system is usually most effective; (*c*) collect and tabulate costs on a current basis preferably by machine-accounting methods; (*d*) analyze by cost centers against budget or standard costs—hold cost-reduction meetings; (*e*) issue regular and current summary reports to responsible supervisors so that follow-up corrective action can be initiated before undesirable costs are repeated.

### Other Records and Controls

The control center does the great majority of clerical detail and paper work for the entire maintenance function, thereby co-ordinating requirements to the minimum essentials, and freeing maintenance supervisors of clerical detail, so they can spend time to best advantage in direct supervision.

A "work-order report," Fig. 4, that analyzes backlog weekly, is helpful in planning; and it is important that the control center maintain a control on backlog. As the backlog increases, it may be necessary to contract some work out to cover peak-load conditions. Conversely, as the backlog decreases, it may be desirable to explore manpower reduction.

Routine-detail data can usually be accumulated most economically by punched-card tabulating equipment. The control center maintains active and completed work-order files, equipment-record files, inspection check lists, and technical data that are helpful in the maintenance of equipment.

### Future Improvement Is Essential

As machines replace men in production operations, more maintenance labor is required to maintain the new machines. Thus it becomes increasingly important that efficient methods and proper controls are established for the maintenance function. In addition, the maintenance function must be "upgraded" to a position of top priority in any plan for successful management. A maintenance control center to plan work, to measure productivity, and to spearhead maintenance improvement is a positive means of receiving both immediate and long-lasting gains. ●

*Press design and manufacture have undergone a transformation since 1953. The modern approach, supplying a complete, integrated press, offers the purchaser*

# EFFICIENCY and SAFETY in

# STAMPING PRESSES

The mechanical press is a machine tool unique both in construction and in the forces it can unleash. It is costly and dangerous. But engineers are making the investment increasingly profitable and reducing or eliminating risks.

In these two papers, one from Fisher Body and one from Minster Machine, the authors report current thinking in the specification and selection of presses, based on plant experience and laboratory tests, and in the design of safety features covering the major areas where developments have advanced pressroom safety.

## Specification and Selection[1]

At Fisher Body, the developing of press specifications is a continuing group effort. Before the purchase of pressroom equipment, there must be an analysis.

First, capital investment: A reasonable return on investment is a necessity. Second, the machine design and construction must provide suitable tooling capacity, versatility from model year to model year, safe operation, required production, and be as maintenance free as practicable. The cost will be depreciated over a period of 15 years, and the machine will be expected to provide good operating characteristics for 25 to 30 years.

These two factors, design and price, cannot be divorced from each other. No piece of equipment, even if it be the ultimate in design, can be a good buy if it does not provide an acceptable return on investment. Conversely, no piece of equipment, at any price, is a good investment if it will not perform the required job or is a major source of down time. The lack of one simple design feature can overrule the selection of a press if this feature is a necessity to the proposed use of the machine. It is therefore required that design be analyzed first. Price analysis can only be put into effect after a design review.

Prior to 1953, all press equipment on the market was in the nature of stripped machines. The press buyer would purchase a press from one source, a lubrication system from another, a press control from another, the drive and adjustment motors from another, and would finally assemble this equipment in his own plant while furnishing

[1] Condensed from "Specification and Selection of Production Stamping Presses," by Carl Pearson, Senior Process Engineer, Fisher Body Division, General Motors Corporation, Detroit, Mich.

Based on two papers contributed by the Safety Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of The American Society of Mechanical Engineers.

the necessary air and electrical assembly at erection. The result was contractor confusion, jurisdictional delays, long periods of erection time, split responsibility as to equipment operation, and a finished product that lacked considerably any esthetic value of appearance.

### The Modern Press

The modern stamping press is more in the nature of a machine tool. Portable presses are complete, requiring only a three-wire electrical connection and an air line connection. Oil return lubrication, press controls, air piping, and safety features are built into the basic press. The larger machines that must be shipped "knocked down" are designed with each subassembly as a complete unit in itself. Assembly is facilitated by adjacent junction boxes for electrics; air piping is connected by flanged couplings.

This packaged-type construction reduces idle time during erection by major proportions; initial cost of installation and recurring rearrangement costs are minimized; and rearrangement and transfer time is cut to a minimum.

There is no split responsibility on the machine design or construction. The press manufacturer is responsible for functional engineering and operation of the press, motors, controls, air piping, and all accessories. Plant appearance is improved by neater appearance.

Logical analysis and selection of modern stamping presses require that machines be engineered to specifications furnished by the press user. Sound specifications assure the press purchaser that each press manufacturer is quoting on the same type of machine with the same degree of completeness.

### Press Specification

A press specification used for competitive buying must keep a major point in mind: Specifications are not intended to interfere with the ingenuity of the press industry in machine design, or to hinder progress in this field. Where practicable, statements should be in the form of performance specifications based upon the press user's experience in maintenance, press erection, safety, die tryout, and production operation. The press industry has been of great service to the stamping industry in idea development, producing designs that provide part-transfer facilities, quick die set, reduced draw speeds combined with optimum stroke-per-minute rates, and so on. We wish to sustain this source of creative engineering.

Two basic types of specifications have been found necessary. First, we require a "particular specification." This applies to a particular press in question. Die space and operational requirements for a single-action press would be spelled out in such terms as tonnage rating, point of rating, length of stroke, minimum opening, etc.

Where a multiple-action press is under consideration, additional items must be specified, such as maximum draw and required characteristics of plunger, blankholder, and third action.

As a supplement to these particular specifications, we have found it advantageous to furnish a die-space drawing to the press manufacturer. He will then have full knowledge of the press user's die-mounting and operating requirements. Such print information may include bolster-mounting requirements, air-pinhole layout and size, "T"-slot layout and size.

With the advent of the packaged or machine-tool type of press, a general specification has been found necessary, one that applies to basic types of presses such as "straight-side" or "gap-frame" presses. The intent of this specification is to convey general information to the manufacturer on items such as content requirements of the press quotations, service-manual content requirements, power-supply and compressed-air service, maintenance considerations, minimum acceptable design practice, general design requirements, and method of shipment.

### Product Design and Styling

The product is the kingpin from which all processing, planning, and tooling are evolved. Future product design may appear remote from present production operations, but it can have an effect on the equipment purchased today. Lack of foresight could obsolete a major expenditure in capital equipment in a very few years.

Conversely, the possible changes in future styling should not cause those responsible for equipment to be conservative to the point of encumbering production plants with oversize, slow, excessive-tonnage equipment. Stamping presses must be purchased for the present model program, but with an eye to probable future styling.

Based on product-design information, the tool engineer can process the part into the required methods of fabrication. Assuming the part is most applicable to production in stamping presses, the die engineer will determine the number and types of operations (blank, cutoff, draw, trim, pierce, form, flange, or combinations of these) that are required. His recommendations form the basis from which a particular press specification will be developed.

### Installation, Safety, Production

Certain phases of press design must be keyed to the general construction of the plants in which the equipment is to be installed. Factors such as crane-cab and hook clearances, scrap-handling and disposal systems, clearance heights of low-bay areas, type of press pits over which the press will be installed, and the general problem of press erection must be considered. Plant engineering must provide details for a general press specification.

The safe operation of a press in production, die set, die tryout, and maintenance is an absolute necessity. Proper guarding of moving parts, elimination of pinch points, interlocked electrical circuits, anti-repeat circuits, proper wiring and piping practices, as well as reliable components and accessories, must be part of a general press specification. Safety problems must be anticipated rather than developed from experience with equipment that was thought to be safe but proved otherwise.

Facilities for part handling through press lines must be provided for high-volume parts to obtain optimum utilization of the press capabilities in strokes per min. Since handling equipment is a plant problem due to model changes and possible production reallocations, thought must be given to the facilities required to support the mechanisms involved. The plants must jointly agree on a basic mechanical handling control to be specified on a press, and design their handling equipment to fit the facilities that will then be provided.

### Tryout and Die Set

Die tryout and die set must be another major consideration for the production plant in order to obtain maximum equipment utilization. Major model changes, as annually occur in automobile production, call for massive die-construction programs and their accompanying die try-

out. In some instances, initial tryout is in one plant, and the tools are shipped to another plant for production. Such a case calls for additional tryout in tuning the dies into the press in which production will run, and also adaptation of mechanical handling to the tools. A yearly tryout program of one million hr is not unusual.

Slow-inch drives, micrometer adjustment of slide, powered slide adjustment, cushion stroke to drop pins clear of bolster top, quick-disconnect features for mechanical handling, faster and better die-clamping systems, and die-loading facilities—all which the plants must agree upon for call-out in a general and particular specification.

The basic machine mechanism is not to be a part of press specifications. A specification of mechanism, other than performance, would only deter progress in the press industry. It is the responsibility of the equipment engineer to develop a specification of mechanical requirements in the nature of a minimum, industry-accepted, design practice. Maintenance accessibility and long equipment life are to be the criteria. Items of such a nature are based on the experience of production and maintenance departments of the operating plants.

# Safety[2]

Much of the increased productivity and added safety in today's pressrooms stems from developments in clutches and brakes, from the positive-type mechanical clutch and constant-drag brake of a decade ago, to the modern air friction clutch and brake.

Engagement of a positive clutch is accomplished through linkage from a foot treadle or two-hand device that trips the clutch mechanism. The clutch is actually interlocked, metal-to-metal, with the crankshaft until completion of a cycle, where a throw-out cam device disengages it. Stopping point at the end of this cycle is controlled by the small amount of adjustment possible in the cam and the amount of pressure applied to the opposite end of the shaft by a constant-drag brake.

### Danger to the Operator

The major area of danger to the operator of the positive mechanical-clutch press lies in the fact that, once engaged, the crankshaft must complete its cycle of rotation before it can be disengaged. It cannot be disengaged on the down stroke.

Picture what happens if the operator locates a piece in the die wrong, or inserts two pieces that were stuck together—and trips the press. If he notices his error, he may unconsciously reach to correct it. There's only one result possible if he gets his hand to the part. If he does not see the error in feeding, he is fairly safe, but, either way, the press is going to be subjected to an excessive overload that may damage the die and will undoubtedly create strains in the press that will fracture the stressed members or shorten their life. Once the trigger is pulled, that positive clutch is going to cycle the press, even if a frame, crankshaft, or operator's fingers are destroyed.

The die setter has his share of problems with the positive-clutch press. Since the only point that the clutch will disengage is on the upstroke near the top, he must engage the clutch in order to bring the press slide down to the die. This should be a power-off operation, but too frequently the main drive motor "stop" and "run" buttons are used as an inching or jogging mechanism. Here again is an open invitation to serious machine damage and personnel injury.

In view of this, an inching bar is often used in holes drilled in the flywheel rim or crankshaft end. But if someone happens to punch the motor-run button before the bar is removed, it can be just as effective as the sword the ancient Romans used to dispense with careless workmen.

High-precision parts, depending on accuracy for proper functioning to start with and subjected to constant sledge-hammer pounding in normal operation, soon begin to deteriorate. Surfaces wear, fatigue, chip, or burr. A burr at the right place could prevent disengagement, and the operator, who might be too sure of the press, could be reaching into the die area when the press continued to cycle. Too much wear on some surfaces, or weakness and failure of some part, could allow unexpected engagement that could trap even the most careful operator.

Normal maintenance on positive clutches will require frequent heavy service operations to replace worn parts. This adds to the safety problem, not only to the service personnel but to other personnel in the immediate area.

### The "Air Friction Clutch"

Today, we are primarily concerned with the pneumatically operated friction clutch, or, as more commonly termed, the "air friction clutch" and its associated brake as applied to mechanical presses. These mechanisms fall into three categories: Air-engaged clutch with separate air-released, spring-applied brake; air-engaged clutch with separate air-engaged brake; and combination of the clutch and brake unit, in which the clutch is air engaged while at the same time releasing the brake. The brake is automatically applied by spring pressure as the clutch air is exhausted.

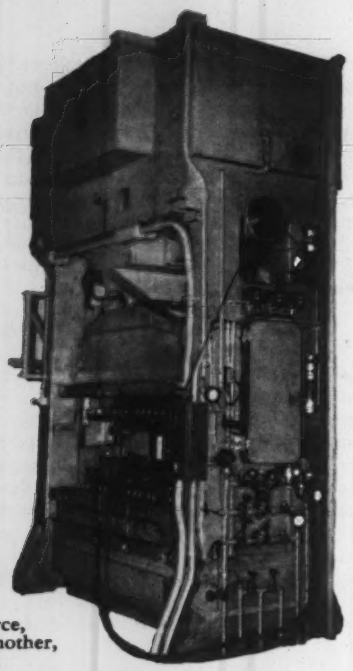
The accepted definition for air friction clutches assumes that the air pressure is internally applied within the clutch unit itself; it does not include those friction clutches that are actuated through mechanical linkage by air cylinders or other devices.

One of the major values of air friction clutches on mechanical presses is that they may be engaged at any point in the press cycle, not just at one point or a few points in the rotation of the crankshaft. Another is that they may be disengaged and the brake applied just as easily at any point in the press cycle, not just at the completion.

This means that the operator has a chance to stop the press on the down stroke when he realizes that a piece is improperly nested in the die or that two pieces are in the die. Such action could prevent die or machine damage and resulting loss of service. The operator will have less tendency to reach into the die to correct his error if he can hit a stop button, correct the error, and continue the operation. It is a strange thing, but the unconscious action of the operator, to endanger himself by reaching into the die area, is subconscious action to save himself from the disciplinary charges brought on by his negligence.

Controlled engaging or disengaging also means that the die setter has a controllable means of inching or jogging the press slide.

[2] Condensed from "How the Change in Design of Presses Has Improved Safety in Industry," by Norman Dunlap, Assistant to the President, the Minster Machine Company, Minster, Ohio.



**OLD** Press from one source, controls from another, drive motors from still another

We can add another item which means greatly increased tool and press protection on automatically fed presses. This is the use of devices in dies to sense jams or misfeeds and stop the press regardless of the cycle.

### Adjustment for Weight and Speed

On the positive-clutch press, only slight adjustment of the "throw-out" or disengaging mechanism was possible. If this failed to stop the crankshaft at the top of the stroke, the only other alternative was to tighten or loosen the constant drag brake tension. With the air friction clutch, variation in die weights, press speed, and so on, means only a minor control adjustment to obtain the desired stopping point at the top of stroke.

### Less Servicing, Less Danger

Naturally there is wear on the friction surfaces. However, replacement of clutch parts becomes a simple and infrequent service problem compared to the periodic rebuilding and service on the positive clutch. Dangers caused by malfunctioning of engaging members of the air friction clutch, due to wear, are almost nonexistent.

Operator safety is greatly increased by his being able to control the clutch. Fatigue is lessened by noise reduction and ease of operation. There is also a reduction of tenseness because he can get greater production on the same speed press with less effort between cycles.

Application of the air friction clutch was not without problems. Toughest of these was the development of electrical controls for starting and stopping—controls that had to be designed and built with special safety factors for the rigors of operational use on presses. They had to provide protection for operators and equipment, and they had to maintain high production.

The objective is to design and build controls in such a way that any failure or malfunction will stop the press. Circuits often include checking and safety features which are designed to help protect the operator against mechanical or electrical failures.

Major units will consist of a solenoid-operated clutch air valve (or valves), stroke limit switch, clutch-selector switches, operator's station (or stations), and the control panel itself. Two of these, the clutch air valve and the stroke limit switch, assume extreme importance when dealing with safe press operation.

Of primary importance is the control of stopping in single-stroke operation, because here the operator is prone to depend upon the press to stop automatically at the end of a cycle which he activated. This is the function of the stroke limit switch, usually a rotary limit switch mechanically driven. It can be adjusted to provide the right lead time in exhausting the clutch air so that top-of-stroke stopping is assured when changes in die weight, press speed, or clutch air pressure have been made.

### The Dreaded Word—"Repeat"

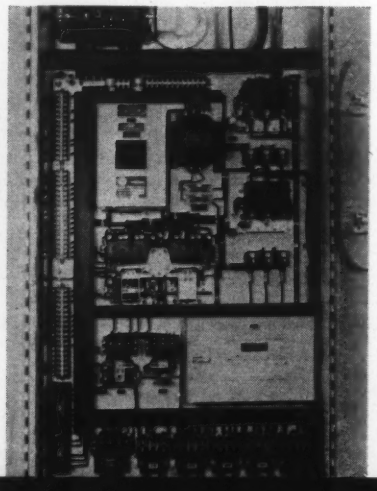
One of the nastiest words in the press industry, either from the press-manufacturing end or the user end, is "repeat." Repeat means that the press cycles without operator motivation when it should be in a stopped position. Cause of such repeats will be a malfunction or failure of a mechanical, pneumatic, or electrical device which is responsible for disengaging the clutch, keeping it disengaged, braking the press, and holding it in a stopped position.

Any failure in the limit switch or its drive, once it has taken over the cycle from the operator, will probably result in a repeat and could mean a serious accident. The emergency stop circuit bypasses the stroke limit switch to the clutch-valve solenoid; but operator recognition of a repeat would come too late to be of value.

Sometimes the cause of a repeat is not traceable. Frequently, so-called repeats are due to the operator's methods and are not due to failures or malfunction.

There is an overused phrase: "Fail safe." Used in connection with press controls, it means that failure of a part or device will not cause or permit the press crankshaft to rotate. That is undoubtedly the ideal situation, but if the fail-safe control were perfect, it would not fail, and, if it is possible for it to fail, it may also be possible for it to fail unsafe. Also, the fail-safe control unit is dependent upon proper functioning of devices or parts which it controls, or with which it interlocks.

Many controversies come up over the proper method of actually controlling a press. Such arguments may be between safety engineers and production departments within the same company, between the press user and press-control manufacturer, between the press operator and the time-study man, and so on. In many of these



Electrical control side of a modern 84 × 36-in. stamping press. Safety features are built in.

controversies, both parties may be right in at least part of their thinking. Modern presses can be equipped with press controls to increase protection of operator, die setter, service personnel, and the press itself—if the purchaser is willing to pay for them.

### The Hand Is Too Quick

It is rather hard to visualize someone's sticking his hand into a die where he knows that tons of force are going to be exerted in the next split second—particularly when he knows it is a gamble in which he cannot win. Yet this does happen. Medical people say there is a definite thought situation, and refer to it as involuntary reflex action. This is a situation where the eyes see that something is wrong and, without thinking, the hand reaches out to correct the error before damage is done to the die. In addition to this operator factor, we could also add the rhythm of an operator in the performance of the cycle—hand feed, trip press, eject part, hand feed. The operator may get out of rhythm, gain on it, turn his head and miss, reach farther for a part, etc.

This type of hand-feed operation is particularly hazardous. It is the easiest way for the operator to expose himself to an amputation every time he places a part in the die. Add dies designed for parts but not for easy operator hand access, small slippery parts, and large flat lubricated sheets of metal which human hands and fingers find hard to grip, and we find that a press operator is lucky to keep his fingers on hand-fed press operations.

Probably the most frequent cause of press repeats is air valves. The thing that must be realized in designing and constructing air valves is how important any failure may be. They are all subject to internal shock caused by high operating velocities, dirty air, scale in the air lines, moisture conditions because of condensation, lack of lubrication, and intense vibration from the press operation. They are also going to wear out.

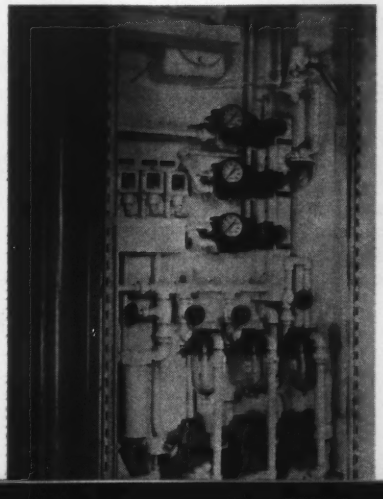
### Two-Hand Controls

In regard to operator stations, most state safety codes recognize two-hand controls as being adequate operator protection. Therefore two-hand controls are common practice in the industry. A problem arises though, because most of those two-hand controls are for single stroking the press only. One thing not covered in the state codes on this point is the inching arrangement, and here is the greatest cause of die-setter accidents.

It is common practice in the stamping industry today to use one-hand inching. One hand, or one button, arrangements are as unsafe as loaded shotguns with safeties off. Many die setters violate one of the first laws of die-setting safety, that of making sure the drive of the press is not in motion before reaching into the danger area. Since the inch and run buttons are usually located adjacent to the die area, a die setter or his helper working in the danger zone could unintentionally bump the inch button and actuate the press if the drive is in motion. This has been one of the most common causes of amputations in pressrooms.

These hazards are easily overcome by providing all inching circuits with two buttons. There is no need to sacrifice inching sensitivity because two-hand inching merely requires the holding down of one button, with one hand, leaving the other hand free to jog the press.

**NEW** Since 1953, presses have come complete, requiring only electrical and air-line connections



Air control side of the same modern 84 × 26-in. press, with integral safety features

### The Fast Press

In fast presses, where it would be impossible for a man to move fast enough to get into the exposure area before the dies were closed, exposure to hazard would be a condition where a press would unexpectedly cycle or start, or would not stop when supposed to do so. The solutions to component failure, such as multiple or dual components, would apply but would be unnecessary on many of these presses that are operating automatically.

Even the old die-hard pressroom foremen will admit that it is a simple matter to guard an automatic machine by fixed-barrier guard which is interlocked with the press control mechanism. Master stop buttons conveniently located in the operator area would provide protection against the machine's running away from the operator.

Die-setter exposure is the same in fast machines, with perhaps some increase in the hazards. On the fast presses there would be less time to move out of the danger zone in case of trouble. On the automatic presses with progressive or transfer dies and other automatic feeding mechanisms, a great deal more care and tryout by the die setter are required. Therefore his exposure in the danger zone will be greater. Two-hand inching should be used as well as any other safety device available. ●

# EXTERNAL DEPOSITS AND CORROSION IN BOILERS AND GAS

By Bertrand A. Landry, Mem. ASME, Assistant Technical Director, Battelle

The importance of corrosion and deposits on the fireside of boiler surfaces or in gas turbines is attested by the vast technical literature available. No such proof is needed for design and operating engineers who have seen the problems grow in importance with the use of increasingly higher temperatures and with no diminution in sight for the impurity content of fuels.

Yet when a comparison is made between the amount of ash collected in a boiler or gas turbine, in the form of deposits, and the total amount of ash released during combustion, the conclusion is clear that most of the ash passes through the unit. Under normal conditions, the walls of a boiler or the blades of a turbine are poor ash collectors. The pertinent question becomes: How should boilers or turbines be designed to make them still poorer ash collectors?

### Mechanism of Deposit Growth

For particles to collect on boiler surfaces or blade surfaces, they must first be brought close to the surface itself and be of the proper size. This can be ascribed to physical phenomena involving the reaction of particles to the forces to which they are subjected within the stream of gases passing near the surfaces.

A particle may hit and then rebound from the surface. If it hits or rubs the surface with sufficient force, erosion will result. On the other hand, if the particle is captured physically or chemically by the surface, a deposit is initiated whose growth appears aerodynamically inevitable. Because of high temperatures, reactions can then take place between the various particles deposited and with the gases passing nearby, particularly $SO_3$ and $SO_2$. The resulting compounds may then react, by diffusion, with the metal structure on which they are attached and cause corrosion. In boilers, a limit to the growth of the deposit may be reached because of the eventual continuous melting of the outside layer, but the corrosive effect may continue.

In this process of deposit growth, a part can be played by many of the mineral constituents found in fuel impurities, particularly after their conversion to active chemical species during their exposure to combustion or furnace temperatures. So many kinds of these may be released that what happens in a boiler furnace or a gas-turbine combustor is not unlike a spectacular conflagration in a well-stocked chemical laboratory. Particularly detrimental are the compounds of vanadium from fuel oils which, as a liquid deposit, can cause rapid corrosion both in boiler furnaces and in gas turbines.

Low-temperature corrosion of economizers and air heaters is a different problem. It is caused by the condensation of acid on metal surfaces either through a lowering of the gas temperature to the dew point or by percolation or diffusion of the acid fumes through a porous deposit to the cooler metal underneath. A deposit which may start from a physical deposition of ash may grow through chemical corrosion and promote further corrosion. On the other hand, the use of certain additives, which increase the dust content, appears to

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*The study of the causes of boiler and gas-turbine deposits, their composition, and their corrosive effect is not simple. Much of the fundamental nature of the chemical reactions, the aerodynamic behavior of the gases, catalytic effects of metals and particles, and the over-all effect of fuel additives is still unknown. The material presented is part of an extensive report on the gaps in existing knowledge of the subject recently completed by Battelle Memorial Institute for the ASME Special Research Committee on Corrosion and Deposits from Combustion Gases.*

# TURBINES

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be beneficial in adsorbing or neutralizing the acid in spite of the possible disadvantage that this may favor deposits.

Obviously, the study of the causes of deposits, their composition, and their corrosive effect is not simple. Primarily, the impurities in the fuel, the temperatures reached with the combustion system employed, and the aerodynamic behavior of the gases fixed by boiler or turbine design are the imposed variables subject to varying degrees of control. Additional knowledge is needed regarding the interactions between these variables which cause deposits, particularly on the fundamental nature of these interactions. But the problems are so severe that immediate palliatives deserve attention. These include the removal of certain impurities in fuels, the inhibition of the complete oxidation of sulfur, physical, or chemical modification of the metal surfaces, the development of alloys having higher resistance to corrosion, the choice of additive for specific actions, and an answer to the question of whether to clean gases ahead of economizers or air heaters.

### Removal of Fuel Impurities

The variety of mineral constituents found in fuels is large. Although all kinds may not be represented in a given fuel from a certain source, the number of them present is still high. Nearly all of these mineral constituents are probably dissociated by the high temperatures of the flame and of the combustion chamber. On cooling, certain dissociations persist and recombinations take place that give rise to chemical species not originally present. The high-temperature chemistry of these reactions is insufficiently known to permit accurate prediction of the nature and extent of these dissociations and recombinations. Even if more were known, it might not be too helpful because deposition, in its early stages, is probably not due to a chemical reaction with the exposed metal. It can be inferred, however, that sodium, calcium, silicon, and vanadium oxides may each be released as such, and that they play an important role in initial deposition or in direct corrosive attack.

A most important impurity in nearly all fuels is sulfur. At combustion temperatures, the sulfur compounds dissociate or are oxidized to form $SO_2$ and $SO_3$. Any free sulfur released reacts with oxygen to form the oxides of sulfur also. Neither of these anhydrides can react appreciably with hot metals below 1200 F, but they can react with the oxides that may have deposited on metal. The oxidation of $SO_2$ to $SO_3$ in the presence of oxygen can be catalyzed by hot metals, by active particles in the gas stream, or by active particles after deposition on surfaces. The net result is that the concentration of $SO_3$ increases as the gases move from burner to economizer. When the temperature is low enough, $SO_3$ will combine with water to form sulfuric acid. This then becomes available to attack metal in the cooler areas.

Mineral constituents in coal or oil that contain chlorine also are dissociated at high temperatures. The free chlorine formed can immediately react with hydrogen to form hydrochloric acid which, alone, attacks metal at relatively low temperatures but which, in co-operation with sulfuric acid, may be quite corrosive at somewhat higher temperatures. Only one instance has been traced to the chlorine content of the coal in the U. S., but many have been reported in Great Britain.

# EXTERNAL DEPOSITS AND CORROSION

The presence of these impurities in fuels presents several research problems. Fuel preparation can attenuate some of them, but the complete removal of ash and sulfur is economically infeasible. This does not seem to apply, however, to the NaCl that may be present. Fuel oil may contain an appreciable amount of this salt whose action may be doubly bad: (*a*) In promoting vanadium attack through the formation of sodium vanadates, and (*b*) in promoting low-temperature acid attack because of the formation of HCl.

Until recently, the chlorine content of American coals was not given much attention. Analysis for chlorine is not standard practice, but it would seem desirable for coal users to add this determination. Whenever desirable or indicated, the removal of extraneous NaCl from coal, by washing, should not be technically difficult.

It is not possible to remove vanadium from oil because it is combined chemically with the oil molecules as an organometallic compound. A less costly technique for removing NaCl than washing and centrifuging should be developed, however. Washing at high pressures and temperatures might not lead to the formation of an emulsion and would not be too costly. Fuel-oil additives to neutralize vanadium could be used simultaneously.

One of the most important and perhaps least understood reactions that follows combustion is the group of reactions responsible for the combination of various oxides of vanadium with sodium oxide. A number of compounds can be formed, and some of those found in boiler deposits have no correspondent among x-ray diffraction patterns of known sodium vanadates. The synthesizing of all possible members of this group and cataloguing their behavior under x-ray diffraction should be an important fundamental investigation.

### Formation of $SO_3$

Since it is economically impossible to remove sulfur completely from coal or fuel oil, it is impossible to prevent the formation of $SO_2$ during combustion. The oxidation of $SO_2$ to $SO_3$ seems to require, however, either the presence of atomic oxygen, which can only occur within the flame, or the subsequent intermediary of a catalyst, but nevertheless occurs in significant proportions.

Some success with oxidation prevention through control of the amount of primary air indicates the desirability of further research.

Most of the $SO_3$ produced is probably formed catalytically, and information is needed on the nature of the materials in boilers (including deposits) that may serve as catalysts for the oxidation of $SO_2$.

Since catalysts may be poisoned or so modified as to be ineffective, better knowledge of the specific catalytic effects present would lead to preventive methods. One approach concerns vanadium compounds which can catalyze the oxidation of $SO_2$. On the other hand, corrosion caused by vanadium can be prevented by the formation of high-temperature-melting compounds by reaction with suitable additives. If this reaction can be made to occur at a high enough temperature, then the vanadium may lose its catalytic properties as well as its corrosive ones. This double-barreled approach deserves attention.

In the absence of a catalyst, the homogeneous rate of oxidation of $SO_2$ to $SO_3$ is low, but may be reduced still further by a reaction inhibitor. Although the concept here is rather hazy, research in this direction would be of fundamental value.

Are the sulfates found in boiler deposits formed while still in the gas stream and then deposited, or is sulfate formation limited to the reaction of $SO_3$ or $SO_2$ and oxygen with an initial basic deposit such as $Na_2O$ or CaO? An answer would represent an important contribution.

Loss of sensible heat by the gases, as they pass through the various sections of the boiler, results in a lowering of their temperature to the point where $SO_3$ can react with water to form sulfuric acid. The questions raised by the presence of this acid in the cooler portions of the boiler will be taken up later.

### Origin of Deposits

The existence of high-temperature deposits is, in itself, a sort of mystery. How do they get there and what holds them when they stick?

Physically, most of the solid material released from fuel impurities passes through the boiler or turbine. This is well as otherwise operation could not continue. It is claimed that new boilers often have a lengthy period of immunity from deposits. This can mean that, with time, the smooth surface of metals can be altered to increase its ability to hold particles. There is evidence that, with time, iron alloys, including steel, can build a microscopic needle structure extending away from the surface; this would be a slow process, but one well worth investigating, as it could point out at least two approaches for correction. One would be a search for alloys not possessing this property; another would be a search for metal coatings that would interfere with or prevent this needle-structure formation.

The other mechanisms of initial deposition which have been suggested, such as the wetting of the metal surface by certain bases or salts or the formation of surface-potential forces leading to specific attractions, also need exploration.

One or more of these approaches might answer the question of what makes the particles stick. But how do they get there? The particles released during combustion are of various sizes; chemical reactions that take place alter their sizes. Physically, however, their behavior in the gas stream—that is, whether or not they collide—depends also on their size in relation to the size of gas molecules and on the state of turbulence of the gases. Such collisions can result in a growth or breakup of the particles depending on their physical state. The size of the particle approaching a tube or blade surface may thus have changed considerably from its initial value. Can the range of sizes formed be controlled, perhaps by more rapid cooling of the liquid particles to limit their size or by enforcing a slower cooling rate to increase their size?

The final size of the particle plays an important role when related to the aerodynamic forces that operate when the particle is projected, or hurled, toward a surface and must cross the boundary layer adjacent to the surface to reach the surface. Further studies are needed to prove what are "favorable" and "unfavorable" size ranges for reaching or not reaching the surface.

Once a deposit has been initiated, a substantial change may occur both in the character of the boundary layer and, if the deposit becomes thick enough, in the aerodynamic behavior of the gases passing nearby. Under certain circumstances, this leads to rapid growth of the deposit. It would seem that too much emphasis cannot be placed on arriving at the optimum design of boilers or turbines to minimize deposition through the use of appropriate aerodynamic patterns of flow. Model work can help solve design problems and could include studies to show that the admission of secondary (or tertiary) air at certain critical spots might go far in alleviating the situation.

### Corrosion Prevention

If deposition is unavoidable, can the corrosive effect of deposits be reduced through the selection of metal surfaces? The field of new-alloy development is so large that there is every assurance that alloys can be found which will have the needed mechanical properties and corrosion resistance. The challenge is one of cost; but the chances remain good, particularly for structural members that are not water or air-cooled.

A promising area for corrosion resistance is the surface coating of metals. This has not been successful, so far, in boiler or turbine applications, but with the variety of techniques and types available it would be surprising if none proved successful.

One aspect of the metallurgical problems associated with deposits and corrosion that must be kept in mind is that of the compatibility of fuel additives with the metals with which they may come in contact.

Because boilers and turbines are normally poor ash collectors, there has been little hesitancy in the use of additives to combat specific nuisances such as vanadium compounds and $SO_3$ because the boiler and turbine could be relied upon not to retain too much of the additive.

However, this has not always been true, and certain additives, while reducing corrosion effects, have added to deposit problems. Special attention, through the use of the proper research equipment, should be given to the complete behavior of additives so as not to solve one problem at the expense of another.

Although the specific effect of additives seems to have been well explored, further research should probably be done. An important aspect is the method by which they are added to the fuel. For gas turbines, a possible but perhaps costly approach is the development of oil-soluble additives for reaction with vanadium. Water-soluble additives should not be overlooked if they can be shown to be equally effective. The presence of a certain amount of water solution in the fuel oil supplied to a gas turbine is beneficial to the cycle if this water does not interfere with pumping, atomization, and combustion. This is not true of boiler-fired systems, but better distribution of the additive might be achieved in this way, at a slight thermal loss.

As to the introduction of fine solid additives in the gas stream of boiler furnaces, the art seems to be still in relative infancy, and applied research will probably be required to smooth out this operation.

The economizer and air-heater sections of the boiler unit represent special problems. It is here that sulfuric acid is finally formed and can start to be troublesome, along with hydrochloric acid, if present, and if temperatures are low enough.

The removal of acid from the gases, before metals are damaged, can occur either by adsorption within the pores or interstices of otherwise inert dust particles, as often happens in pulverized-coal firing, or by neutralizing the acid by reaction with a basic particle. If the coal fired does not produce enough fine particles having adsorptive properties, then the use of a neutralizing rather than an adsorptive additive seems indicated because of lower cost owing to lower tonnage requirements. Evaluations of available adsorptive and reactive materials in a given locality and of methods of application should be made before a choice is made.

Adsorptive material to remove the acid from the gases before the metal of the air heater is attacked is sometimes naturally provided, and sometimes provided by an additive. There are two other possible solutions to the problem of acid attack, both of which have the advantage that no additive is needed.

One is to develop an inhibited metal surface which resists acid attack while not interfering markedly with heat transfer. It is known that iron compounds can receive this inhibiting treatment. Can it be applied to air heaters?

The other approach, which deserves thorough study, is based on the theory that the presence of a porous deposit on air-heater metal tends to make the temperature of the metal more nearly that of the air being heated than that of the gases supplying the heat. Therefore, acid fumes which have not reached the dew point, while mixed in the gases, can reach it when they have diffused through the deposit to the metal. Corrosion then occurs. Under this theory, it would be advisable to remove all or nearly all of the solids ahead of the air heater or even the economizer. With no solid deposit, there would be little or no corrosion.

Finally, it should be pointed out that the correlation between the determinations of the sulfuric-acid concentration in gases by the dew-point methods and by chemical methods is not good. Many of the results obtained in studying corrosion are not comparable because dew-point determinations were used to measure acid concentration. The fault may lie in using inaccurate dew-point meters. If various hydrates of $SO_3$ can exist, however, the chemical method may not differentiate between them, whereas their corrosive effect may be different. Fundamental research in this area is strongly indicated.

This listing of possible avenues of research on corrosion and deposits shows that many gaps exist in our present knowledge. Much of the experimental and inferential work that has been done to date has, however, contributed greatly toward the formulation of these questions.

Undoubtedly, several of these approaches will be unrewarding, but others should be successful. There is no doubt, though, that, after a new period of research, other questions will arise. Research results produce additional knowledge, and additional knowledge suggests new research. ●

# THE PROFESSION MECHANICAL

*Where does the mechanical engineer fit into the sequence that*

DELINEATION of the boundaries of the engineering profession is made difficult by the fact that it merges gradually into adjoining areas of work—science, management, manufacturing, and others. Engineers in any specialty not only practice engineering but they also engage in many other activities, some borderline and some clearly nonengineering, judged by any reasonable definition of professional work.

Mechanical engineering is the art and science of converting design concepts into working "hardware" which can be manufactured and sold at a profit. Mechanical engineers are professional practitioners who have acquired, through education and experience, special skill in this activity.

To those who regard this definition as narrow, it should be answered that it blocks out for the mechanical engineer a central and permanent segment of engineering work, and one which is in no sense secondary or ephemeral. Particular applications such as steam-electric power plants, reciprocating engines, and other similar developments will pass through their life cycle from exciting novelty to technical maturity, and on to ultimate displacement from the engineering scene. But the talents of the mechanical engineer will always be essential to the welfare and advancement of society.

### An Idea Takes Form

Consider the phases through which a novel technical idea progresses on its way to successful utilization. For convenience, it will be broken down as follows:

1 Identification of the worth-while technical objective. Physical feasibility, economic justification, market acceptance, military need, and a host of factors may enter the appraisal of what is worth while.

2 Visualization of a functional design which would, in principle, achieve the technical objective—a conceptual design in quantitative terms. For example, if the objective is to improve engine fuel economy by increased compression ratio, one can develop a conceptual design in terms of pressure-ratio, fuel-oxidant ratio, flame speed, and other combustion and flow quantities without consideration, at this point, of the manner in which these phenomena could be contained, or of the cost.

3 Analysis of the quantitative requirements of the functional design—temperatures, pressures, rates of flow, corrosive properties, power required, reliability, life, transient states, control limitations, and whatever other quantities are pertinent—and visualization of an assembly of real components which might be suitable to contain and control the functional design.

4 Quantitative analysis of the critical features for stress, heat flow, impact effects, creep, fatigue, thermal stresses, vibration, lubrication, and so forth, to permit a preliminary layout and an estimate of cost.

5 Detailed design and preparation of working drawings.

6 Manufacture, inspection, test, redesign, retest, cost analysis, release for production, tooling, quality control, and so forth.

The hard core of mechanical-engineering work is described by the items beginning with 3 above. Obviously, mechanical engineers may participate in steps 1 and 2, but so also do scientists, inventors, businessmen, and engineers in other specialties. It is the chain of events between solution in principle and realization in hardware which is the peculiar contribution of the art and science of mechanical engineering. Men of demonstrated competence in this type of work may reasonably claim the title of mechanical engineer, whatever may have been their education and experience.

There are major segments of industry—prime movers, machine tools, manufacturing methods and processes—in which the mechanical engineer himself develops the functional design. The feedback of knowledge and judgment from the mechanical engineers, when their contribution begins at item 3, influences strongly the decisions reached on worth-while objectives and functional designs.

### Judging the Project

Judging novel engineering projects for their technical

[1] Dean, College of Engineering. Chairman, Department of Mechanical Engineering, from 1937 to 1943.

# OF ENGINEERING

## What is the Function of a MECHANICAL ENGINEER?

*begins with pure science and ends with whirring machinery?*

By M. P. O'Brien,[1] Mem. ASME
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and economic feasibility is the highest level of engineering activity. Success in this type of work requires effective collaboration with other groups—scientists, engineers, businessmen, bankers, public officials—if the objectives are to represent an economic or social gain sufficient to justify the effort without, at the same time, involving an unacceptable risk, either technological or financial.

Ideas for new devices are "a dime a dozen," as the files of the Patent Office demonstrate. The difficulty is to identify ideas which are worth while when judged by appropriate criteria. The Wright brothers developed the airplane to satisfy an inner urge and, initially at least, without the prospect of financial gain; military equipment cannot be appraised on a monetary basis; social needs for engineering works frequently cannot be evaluated on a dollar-and-cents basis. Other examples could be cited, but the usual criterion of what is "worth while" is the money potential—will the return in money probably be sufficient to pay the entire cost plus a profit sufficient to justify the investment and the risk?

The monetary criterion of the desirability of a project is usually dominant, but there are also intermediate considerations which must be weighed. A proposed development may be demonstrably impossible on the basis of physical principles; but a more usual situation is that the technical objective is achievable in principle but is not feasible for reasons of the technology available. Leonardo da Vinci understood the principles of flight, and might well have mastered the problems of stability, but he was not supported by a technology providing high strength-weight ratio structures or effective propulsion. A development may measure up to all physical criteria and meet an obvious need but be unsound for reason that the volume of the demand may be insufficient.

A series of approximations is required to appraise engineering development, because a complete design would be required to fix exactly the performance and cost. But the question at the outset is whether to commit the engineering effort required even for a preliminary design. Intuition, imagination, experience, judgment—and sheer luck—enter at this point. The hazard, here, is that an unduly conservative attitude—an unwillingness to take any technological risk—will dump the good with the bad and produce no progress whatever. The choice of technical objectives requires a trivial fraction of the over-all engineering effort, measured in man-hours, but constitutes the dominant factor in the success of individual projects and companies and in the quality of the technology of a nation.

### The Functional Design

Ignoring for the moment the feedback and the series of approximations necessary in arriving at worth-while objectives, and idealizing the process as a single sequence, the next step is to conceive a functional design.

The degree of creativeness and ingenuity required for success in both the functional and in the mechanical design will vary with the novelty of the objective and with the "mix" of science and technology involved. But the process is fundamentally the same for a completely new type of component or system as for a routine change. Quantitative analysis cannot proceed until someone visualizes a configuration or a process for analysis. It is the capacity to visualize designs—functional or mechanical—sufficiently close to an acceptable solution to be worth the effort of analysis, which constitutes the art of engineering.

Parenthetically, engineering education deals almost exclusively with analysis of concepts developed by others—usually by professors and by authors of textbooks—and little or no attention is given to the intuitive synthesis of designs to meet specific objectives. Perhaps creative design cannot be taught,[2] but where the talent exists it should be exercised—or at least it should not be inhibited by the impression that engineering problems have one approved solution, and that useful engineering results can be achieved by analysis alone.

### Scope of the Profession

As defined in the preceding notes—namely, the art and

[2] Three papers on creative engineering, its teaching and development, appeared in MECHANICAL ENGINEERING, February, 1958, pp. 74–80.

# THE PROFESSION OF MECHANICAL ENGINEERING

science of realizing functional designs in working hardware, usually for sale at a profit—mechanical engineering lies near the middle of the main stream of all engineering activity. It is essential to almost every industry and to every phase of technology—either directly, or through the related industrial complex which provides the necessary components and systems. It is this tremendous scope of the applications of mechanical engineering which gives this profession its strength, and which also leads to haziness as to its exact nature and the desirable educational preparation for it.

The fact that mechanical engineers may apply their art and science in every industry and in every phase of technology does not justify the conclusion that mechanical engineering is an all-encompassing profession under which all other branches fall. Mechanical engineers participate in the design of nuclear reactors, and the ASME gives attention to nuclear engineering in its publications, but this does not mean that nuclear engineering is merely a branch of mechanical engineering.

Confusion of the core activity characteristic of mechanical engineering probably presents no real problem to the practitioners of the profession, but it has misled the schools preparing students for this profession, and has resulted in an unfortunate haziness about educational goals and criteria. It is the opinion of many deans that mechanical-engineering departments have lost contact with the main thread of the profession—both through attention to applications in mature industries on the one hand, and through an unbalanced attention to certain engineering sciences on the other—and that a redefinition of the nature and scope of the profession is a desirable prelude to a discussion of the educational programs.

### Self-Examination

The tremendous scope of the industrial applications of mechanical engineering renders difficult the selection of suitable academic programs. It is appropriate to mention that the profession of chemical engineering once faced a similar situation, and that a thorough self-examination, and consequent actions, resulted in major gains for that profession. The time has come for mechanical engineering to look at itself and to decide whether there is a common thread of professional interest running through the myriad activities in which its practitioners engage. ●

# EDUCATION

***The "heroic age of physics" now demands all the universities has a responsibility in the***

SIR CHARLES SNOW quotes Lord Rutherford[2] as saying in 1923, and continuing to say until his death in 1937, "We are living in the heroic age of physics."

Snow observes: "There had never been such a time. The year 1932 was the most spectacular year in the history of science. Living in Cambridge, England, one could not help picking up the human, as well as the intellectual, excitement in the air. Sir James Chadwick, gray-faced after a fortnight of work with three hours sleep a night, telling the Kapitza Club how he had discovered the neutron; P.M.S. Blackett. . .not quite as authoritative as usual, because it seemed too good to be true, showing plates which demonstrated the existence of the positive electron; Sir John Cockcroft, normally about as given to emotional display as the Duke of Wellington, skimming down King's Parade and saying to anyone whose face he recognized: 'We've split the atom! We've split the atom!' "

Although not all the exciting things of this heroic age occurred in England, few of them occurred in America. The scientific revolution moved from Europe to America during World War II. Following it, as surely as day follows dawn, came a technological revolution into which we are now only entering. The application of electromagnetic field theory, quantum statistics, and nuclear processes to social ends has only begun.

### Where is the Engineer?

So far, the engineer has played a secondary role in the new technology. He has tried to bolster his self-respect by telling himself and others that, after all, a safe nuclear reactor cannot be designed without the science of heat transfer which is an "engineering science"; but it is evident, nevertheless, that heat transfer is the hand-maiden science. The master science, and therefore the master engineering, has had to come from the physicist.

We may contrast the engineer's position of the past two decades with that of Lord Kelvin, a great engineer of a century ago. Kelvin helped to formulate the laws

[1] Professor and Head of the Department of Mechanical Engineering.
[2] *The Atlantic*, vol. 202, Nov., 1958, p. 76.

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IN TRANSITION

# What Should We Teach a MECHANICAL ENGINEER ?

*an equally great age of engineering. Industry as well as development of the nation's engineering potential.*

By J. H. Keenan,[1] Fellow ASME
Massachusetts Institute of Technology, Cambridge, Mass.

of thermodynamics, and he was in the forefront of the engineering developments of his time. He yielded first place to no physicist.

Fortunately, the engineering profession in general, and the mechanical-engineering profession in particular, is aware of this relative decline in its fortunes and is determined to correct the unfavorable trend. The engineering schools are setting out to train scientist engineers who will be equipped to move into the forefront of engineering research, development, and design.

This development in engineering education brings with it many problems. The first is the question of the distinction between engineering and science. The essential difference lies in their objectives. The objective of science is to know or understand nature; the objective of engineering is to use the resources of nature to social ends. In the zone of overlap we find scientists whose new knowledge has led them into applications or engineering, and engineers whose experience in design or development has led them into scientific research.

As engineering educators intent on training scientist engineers, we must not forget that the engineer must not only understand nature, but he must bridge the gap between understanding nature and doing the thing desired. Those who admonish us not to forget this important function invariably point out that it requires imagination, intuition, and judgment. We must not ignore, however, the fact that these three admirable qualities are as essential to creativity in science as in engineering. The scientist must bridge the gap between the known and the unknown, just as the engineer must bridge the gap between the known and the desired.

### To Bridge the Gap

To inculcate the qualities which will bridge the gap is the most difficult task of the teacher, whether of engineering or of science. It is difficult because in this there are no rules to be learned. Rules, in fact, must be avoided like the plague. All that can be transmitted from teacher to student is an attitude of mind and an evanescent art.

One means for teaching the art of engineering is to expose the student to a personal experience in design under the critical eye of an artist. The teacher of science must use the same device, substituting research for design. Again no line can be sharply drawn. Design and research blend into each other.

Teaching the art of engineering or the art of science is like teaching the art of painting portraits. It requires first and last a man who is not only a devoted and effective teacher but a practicing and accomplished artist as well. This is a combination hard to find—harder to find among engineers, perhaps, than among portrait painters. The traditional course in power-plant design, for example, was usually taught by men who were neither practicing nor accomplished artists, however devoted they may have been as teachers. Some more recent design courses have been built around servo and control mechanisms. These mechanisms have the advantage that they are small enough so that they can be designed and developed within the walls of a university. Thus the artist may practice his art on the campus and so bring it alive into the classroom and the laboratory.

The thesis or research project is, like design, an effective device for teaching the art. A staff member who is exploring by analysis and experiment new methods toward desired ends, often proves to be an effective artist-teacher.

The teaching of science, although the easier of the two tasks, presents problems aplenty. First of all, we must decide what we should teach. At M.I.T. we have had several groups working on this problem. They come up with a list of subjects and lists of contents of subjects. As one of my colleagues put it, the result is obviously a program to train people to be M.I.T. professors.

Any such tabulation is of little value until it has been tried in the practice of teaching by a critically minded group of teachers. A foregone conclusion, in my opinion, is that, for all but a minute fraction of the available students, the amount of material to be covered in four years, according to any tabulation I have seen, is far too much. My own experience as a teacher, which seems to be borne out by some objective testing, is that the way to learn is by mastering the easy parts of a subject even at the expense of failing to cover more difficult parts.

### Student Capability

What is difficult to one student, however, will be easy to another. And here we come to a national problem in education. The American interpretation of democracy has too often been equal facilities available

to all, rather than facilities for full development of potential available to each.

Our schools of engineering have all too seldom broken free of the traditional interpretation. For nearly twenty years we have had an Honors Course in Mechanical Engineering at M.I.T. Since it has never, however, recognized advanced accomplishment by any relaxation of the credits required for a bachelor's degree, the Honors men frequently get the bachelor's degree for the same level of accomplishment that others get the master's degree. Moreover, the Honors Course has been frequently eyed with disfavor precisely because it separates out for a minimum of distinction the student who shows unusual professional promise.

The sweep of Sputnik across the sky has shaken public confidence in this kind of equalitarianism. Already many secondary schools throughout the nation have set up special subjects and special courses of study for the superior student. In engineering education we should be no less ready to encourage the scholar.

Teachers of engineering science have often observed that their students can be roughly divided into two groups: One consists of those who can assimilate rapidly, and are stimulated by, the rigorous logical and analytical scientific discipline; the other consists of those who assimilate science slowly. Among this latter group are many whose creative faculties are damaged by too much struggle with alien disciplines. The continuous conflict between the conclusions of science and their own intuition results in the inhibition of their intuitive and imaginative processes with no compensating release of other creative powers.

### Two Kinds of Curriculums

At least two distinct kinds of curriculums seem indicated. For the first group of students we should provide a demanding course of analytical subjects interspersed with just enough practice in the art to maintain contact with reality.

If the student is stimulated by his analytical studies, he can do with less study of the art than can his less analytical fellows—at least for the first four years. He has a big job before him in mastering mathematical language, logical techniques, and knowledge of things and processes in nature. These he must master in the minimum possible time. For we must remember that talent of this sort often flowers early, and our educational process should not delay the flowering. We should remember that in the scientific-technological revolution of a century ago, Kelvin, Clausius, and Carnot each had published a major work for which he is chiefly now remembered, before his 29th birthday.

The program for the second group, on the other hand, should be more deliberate in pace. It should present analytical material with scientific rigor, but with adequate time for drill in elementary material. Liberally interspersed with the analytical should be the artistic material of engineering, done with all possible vitality and authenticity.

Each group should devote an important fraction of its studies to humanities and the social sciences. Whether the two groups should be given the same succession of subjects in these areas at the same pace, is a matter for those who teach to decide. It seems probable, however, that the considerations which prompt separate programs in science and engineering will be equally in evidence here.

### Capturing the Imagination

An overriding consideration in all planning of engineering education must be the aim to capture the imagination of the student. Aside from our own views of what the student will need in his professional future, we must offer him more science than in the past, if only because the age he has grown up in has inspired him to want it. We must use and amplify the motivation which he brings to us.

The basic disciplines that will be required 20 years hence will be essentially the same for the electrical, the chemical, and the mechanical engineer. As in the past, migration between these professional areas will be common, and its magnitude will to a degree measure our success as educators.

The differences between these engineering departments will lie largely in the arts of engineering. It will be the artists of mechanical, electrical, and chemical engineering who will largely provide the distinctive color of the environment in which the student will work. And it is the motivation which the student brings to us which will determine his choice of environment.

Carrying this argument a step further, we can show many reasons why a separate department of engineering sciences, in parallel with the traditional departments, is unnecessary and undesirable. It is unnecessary because engineering science has grown up within the traditional branches of engineering. To extend and improve should be easier than to build from ground level. It is undesirable because it seems highly improbable that two types of program with essentially identical objectives can coexist in equilibrium. One is almost certain to rob the other of vitality. This sort of instability exists even between traditional departments, but tradition and national professional societies are stabilizing influences which help to maintain a healthy balance. Between traditional departments and a department of engineering science a wholly unhealthy competition for staff, students, and funds could well develop.

### Industry Follows Through

Industry, as well as the university, has a responsibility in the development of the engineering potential of the nation and of the world. It should be as alive to the problem of capturing the imagination of the young engineer as the university. It is as much the job of industry to adjust to the needs of the young graduate as it is the job of the graduate to adjust to the needs of industry.

Happily, the day of the long shop apprenticeship of the engineer has passed in America, although it lingers on in some other parts of the world. Nevertheless, the young engineer, even today, can often advance his career more rapidly by continuing several years beyond his master's degree than by going into industry.

We have moved in a few short years from reciprocating engines to rockets, from 300 mph to thousands of mph, from the surface of the earth to interplanetary space. And the rate of technological development continues to increase. American education and American industry need only provide a favorable environment for the young engineer, and he will make of the decades just ahead the heroic age of engineering. ●

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

# BRIEFING THE RECORD

## Supercharged Automotive Gas Turbine

FORD MOTOR COMPANY has announced a 300-hp supercharged gas turbine known as "The 704" engine with a weight only one fourth that of a truck diesel engine of comparable horsepower. The fuel economy rivals a diesel and is superior to conventional gasoline engines under most operating conditions. Maximum fuel economy is attained in the entire range of 25 to 100 per cent of full power. The engine has high reliability and long life.

To date, experimental gas turbines designed for trucks and passenger cars have employed one stage of air compression. The Ford 704 has two—one a supercharging stage—enabling the engine to deliver more horsepower from a smaller size. Early designs have only one combustion chamber where the 704 has dual burners.

The Ford 704 weighs 650 lb installed, complete with all accessories built into it and requiring only the addition of electrical power and fuel. A diesel truck engine of comparable horsepower weighs about 2700 lb.

The "package" size of the 704 is approximately 38 in. long, 29 in. wide, and 28 in. high. It would fit easily into the engine compartment of a 1959 Ford with room to spare.

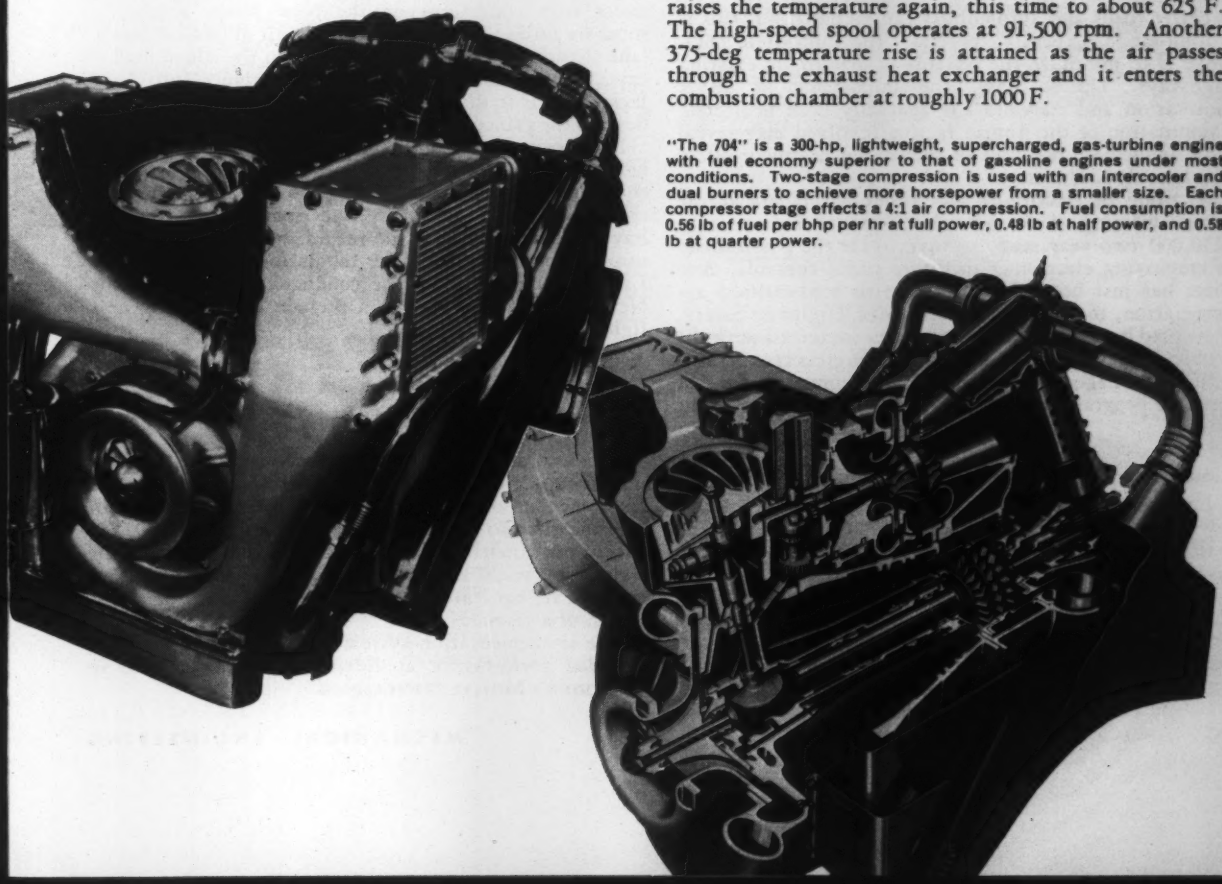
A wide variety of fuels can be used—unleaded gasoline, kerosene, jet-engine fuel (JP4), or light diesel fuel—and no warm-up period is required.

Operation is as follows: Each compressor stage effects a 4 : 1 air compression.

Air is drawn into the first, or low-speed, compressor which operates at 46,500 rpm. Assuming an ambient air temperature of 100 F the 4 : 1 compression ratio raises air temperature to approximately 450 F. At full engine power air flow is 2.7 lb per sec.

The air next passes through an intercooler, required by the principles of thermodynamics, where its temperature is reduced to about 220 F. The intercooler is an integral part of the engine, employing a centrifugal-type blower driven at 19,000 rpm, through a step-down gear, from the shaft of the low-speed compressor.

After cooling, the air passes to the high-speed compressor and through another 4:1 compression stage which raises the temperature again, this time to about 625 F. The high-speed spool operates at 91,500 rpm. Another 375-deg temperature rise is attained as the air passes through the exhaust heat exchanger and it enters the combustion chamber at roughly 1000 F.



"The 704" is a 300-hp, lightweight, supercharged, gas-turbine engine with fuel economy superior to that of gasoline engines under most conditions. Two-stage compression is used with an intercooler and dual burners to achieve more horsepower from a smaller size. Each compressor stage effects a 4:1 air compression. Fuel consumption is 0.56 lb of fuel per bhp per hr at full power, 0.48 lb at half power, and 0.58 lb at quarter power.

Fuel is added and the mixture burns in the primary combustion chamber. At 1700 F the exhaust gases drive the high-speed turbine that turns the high-speed compressor spool. Supplying power to the turbine wheel reduces the temperature to about 1350 F.

Possible applications besides cars and trucks might include tanks, heavy-duty tractors and bulldozers, half-tracks and off-road vehicles of any type, auxiliary or stand-by-power generating sets, starter carts for jet aircraft, earth movers, and even small locomotives.

Ford expects to be testing the new engines in vehicles before the end of the year.

Additional fuel is added in the secondary combustion chamber to bring the temperature back up to the 1700 F. From here the exhaust gases pass through the power turbine, driving it at a speed of 36,000 rpm, and through two turbine wheels that drive the low-speed compressor.

Next the exhaust gases move to the heat exchanger where they release heat to the incoming air after the second compression stage. They are rejected into the atmosphere at about 740 F, roughly the temperature of exhaust gases from a conventional passenger-car engine.

The power-turbine shaft, through a step-down gear arrangement, turns the drive shaft at 4600 rpm at full power.

The Ford 704 gas-turbine engine is designed to burn 0.56 lb of fuel per bhp per hr at full power, 0.48 lb at half power, and 0.58 lb at one-quarter power.

## Human Factors on Highways

CONCERN over the average daily toll of 100 traffic fatalities is reflected in new approaches to highway safety reported in the *Industrial Bulletin* of Arthur D. Little, Inc.

Better roads and automobiles can be built, but this is a long-range, expensive process; the immediate challenge is to minimize the hazards of driving on existing highways. Up to now, the importance of driver motivation and response has generally been neglected. Examination of the human factors involved may reveal more immediate methods of improving highway safety at relatively low cost.

A group of electronics and traffic specialists at the annual meeting of the AAA last September proposed a $150,000 two-year study to investigate the possibilities of employing electronics in future traffic control. And there has just been established, with a $1-million appropriation, the Insurance Institute of Highway Safety, sponsored by 532 insurance companies concerned with the problem. A recent law passed by Congress also permits states "to negotiate and enter into compacts for . . . research programs on the human factors affecting traffic safety."

### Human Behavior

Enforcement is a practical possibility only if a traffic law is compatible with "sensible" behavior, that is, action which can be expected of the normal driver when faced with a given set of road conditions.

If there is any significance, other than statistical, in the fact that roughly half of all motor-vehicle accidents investigated by police departments involve only one car, perhaps it lies at least in part with failure of the highway to "communicate" properly with the driver.

Until now, signs, signals, and pavement markings have been merely suggestive, tailored to fit a general standard for the "average situation," which, like the "average man," does not exist.

A recent opinion is that signaling elements ought to correspond with specific local conditions, to provide the motorist with an accurate mental image of what he will in fact encounter. The location, curvature, bank angle, grade, and roughness of a road are fixed factors. But by taking into account their influence on required maneuvers and the safe and "comfortable" speed which they induce, advance signing can be made more effective.

Inducing a driver to fit his behavior to the physical situation ahead may not be as difficult as it seems, since the motoring public has some reflexes already built in. There is, for example, sufficient evidence that the narrower the road, the lower the comfortable speed. A lower speed might be induced in advance of an intersection by simply making the highway appear narrower, through suitable marking. The solutions to many such problems may well be economically achieved with a "gimmick," whether it be painted lines with visual impact, a properly timed series of lights flashing in sequence to indicate rate of travel, or a rough road surface to provide physical and audible sensation. More speculative, but following similar reasoning, is the suggestion that traffic and vehicle lights correspond in shape to signs already in use. An octagonal red light might thus strengthen mental association to improve compliance with the stop sign.

### A Growing Problem

Road design to achieve safe vehicle speeds and spacing is a growing problem, particularly where "weaving" is required. An example is the proposed second deck for the George Washington Bridge. It is estimated that under rush conditions on the New Jersey approach, some six miles will be needed to permit all the necessary lane changing. In the other direction, the added load is expected to boost to 12 miles the distance into New Jersey needed to disperse the traffic to the point of normal flow on the principal road.

In Westchester County, N. Y., electronic devices are being used to determine how motorists react when they encounter various types of dividers, fences, curbs, and converging lanes of traffic; the paths of 300,000 cars have been checked and the recorded results will be fed into automatic machines for tabulation and correlation. Later, similar tests will be conducted at night on the New England Thruway as a prelude to installing new lights.

## "Light-Foot" Quantizer

A NEW sled-speed evaluation system utilizing a unique space-time quantizer developed by Computer Equipment Corporation, Los Angeles, Calif., will measure time to an accuracy of one part in 278,000,000. Electronic counting circuits are used that measure one light foot with accuracy—the time it takes light to travel 1 ft, equivalent to one one-thousandth of a millionth of a second.

The instrumentation system will be used to evaluate test-sled performance at Edwards Air Force Base in California's Mojave desert region.

## Small Component-Motor Design

A UNITIZED small component-motor design, that is up to 40 per cent more efficient than conventional motors of the same type, has been developed by the General Electric Company's Specialty Motor Department, Fort Wayne, Ind.

Available first in 4-pole, KSM-59 frame shaded-pole and permanent-split capacitor ratings up through $^1/_{15}$ hp, the revolutionary new motor is designed for use in such air-moving and small-machine applications as ventilators, heaters, dehumidifiers, air conditioners, and coolers; and for recorders, projectors, and business machines.

A complete line of the new motors will become available as designs are developed.

Smaller in size for a given output than motors of traditional design, the Unitized motors will offer the original equipment manufacturer a number of options based upon his motor-driven equipment requirements. The new design offers either higher output for the same size, input, and temperature rise; or lower current input for the same size, output, and temperature rise; or lower temperature rise for the same size, input, and output.

New developments in the bearings—which are permanently aligned on the motor shaft during assembly, the rubrication system—which requires only annual reoiling, and the insulation—which employs a specially developed lesin, contribute to the over-all life and performance characteristics. The flexible Unitized motor design can be adapted easily to specific needs of a variety of small motor-driven products by a variety of mounting arrangements, shaft extensions, and lead materials.

## Handwritten Computer Instructions

AMONG the approaches to the simplification of computer-input problems is the study of pattern recognition. Simplified inputs in the form of a limited vocabulary of vocal instructions have already been developed (MECHANICAL ENGINEERING, December, 1958, p. 78).

The ultimate goal of pattern-recognition studies would be a computer which could accept handwritten inputs. The direct reading of handwritten operator toll tickets for billing is one very practical aim of systems research on the subject at Bell Telephone Laboratories. There are numerous other applications. Automatic bacteria, droplet, or metallographic pattern counts from microscope slides are some

Some devices now "read" material printed in a specialized type face, but the numerous variations in handwriting both for a single individual and for different people make handwriting a complex problem.

The field is so new that the ultimate method has not yet been selected, and Bell Laboratories has devised a generalized scanner that can theoretically be used in conjunction with a digital computer to study any logical pattern-recognition system that might be devised. This eliminates the need for building individual, complete experimental models of many systems.

A cathode-ray-tube, flying-spot light source scans the pattern to be studied. The scan is programmed to move from any given point on the pattern to any other point in 200 microseconds and then to succeeding points in the same constant time. Any path can thus be programmed into the scan by a sequence of such instructions.

The light source actually scans two areas at once. One contains the document under study. The other contains a blank piece of paper which provides an intensity reference to compensate for changes in cathode-ray-tube intensity, angles of reflection, and light-spot velocity variations.

Light reflected from a particular spot on the document is focused on a pair of photomultipliers, each sensitive to a different color. The second color is particularly useful for providing position reference marks.

The scanner has a resolution of 100 lines with 10,000 resolvable points and a scan field variable from $^1/_8$ in. sq to 3 in. sq. With a magnetic-tape input, it has a capacity of 60,000 instructions and can execute these at a rate of 4000 per sec.

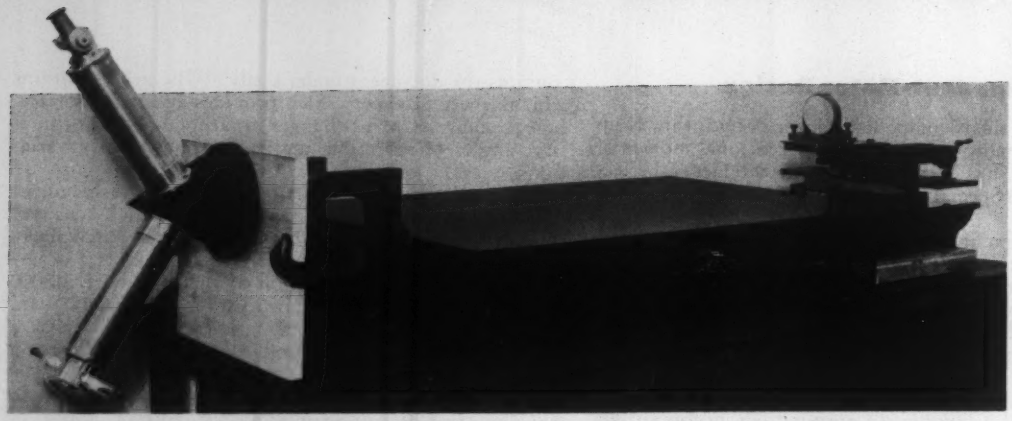
Various scanning paths have been suggested: Left to right and line by line as in television, zig-zag, radial, or any variation. With these, a letter or number could be described in computer language as a sequence of light and dark areas (grays are considered black). The blacks would be registered as the scanner crossed a particular section of a letter. One analysis recognizes 400 discrete points in the area occupied by a single letter.

In one five-row wide by six-vertical-row model of a field-analysis method, illustrated in the photograph, a printed capital T is represented by ON switches in the second horizontal row and ON switches in five of the six positions of the middle vertical row.

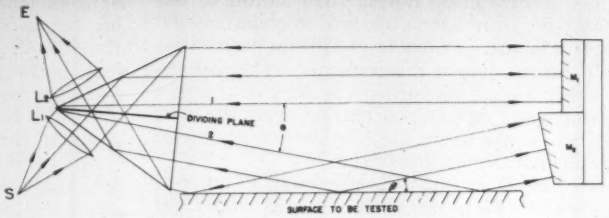
To extract the essential pattern of the letter T, in this example, the individual ON switches can be ignored, and only the point at which one ON switch has neighboring switches (in this case to the left, right, and below) and its own switch in the ON position can be accepted as the key identification. Capital A would have one three-neighbor identification at the apex, and two three-neighbor-plus-self identifications at the points where the cross bar intersects the slants. Other characteristics such as curves (J), or all straight line (I)—serifs are ignored, here, to make description simpler—could also be identified by neighboring relations of switches.

In analyzing handwriting, statistical analyses will have to be made of the degree of variability in forming individual letters. Whether the machine method will ever be as good as the human one in reading some handwriting will remain to be seen.

One form of pattern recognition is demonstrated by setting up the letter T for analysis in terms of switch positions. The letter can then be described as characterized by one switch with three neighboring switches in the ON position (left, right, and below).



The viewing lens and light source in the pilot model of a surface-plate interferometer are to the left of the 91-cm-long plate. The light source is split by the double-image prism. One image is reflected directly back from the mirror, $M_1$; the other is reflected off the test surface. Irregularities in the interference fringe indicate surface unevenness.




## Interferometer for Large Surfaces

"An Interferometer for Testing Large Surfaces," that is relatively simple and easy to operate, is twice as sensitive as the Linnik interferometer,[1] and is relatively free from vibrations, has been described in a paper by J. B. Saunders and Franz Gross of the Engineering Metrology Section, Optics and Metrology Division, of the National Bureau of Standards in the *Journal of Research* of the NBS. No assumption need be made of the continuity of surface features as in the present method of testing with an autocollimator.

The interference fringes on the superimposed images of two mirrors are viewed by the observer and small irregularities of the fringe pattern are a function of the irregularities of the test surface. If the test surface is perfectly flat, the fringes are straight and parallel. The resultant fringe pattern is a contour map of the surface relative to an arbitrarily chosen plane, and the contour interval is a function of the wave length and angle of incidence.

Light from a source $S$ is collimated by a lens $L$, and separated into two coherent beams by the semireflecting dividing plane of a Kösters double-image prism,[2] as shown in the illustration.

The entrance angle of the collimated light may be adjusted to give any desired deviation $\theta$ between the component beams, 1 and 2. Beam 1 is reflected normally from the mirror $M_1$ and returns upon itself. Beam 2 is reflected from the surface to be tested at an angle of incidence of $(90\text{-}\beta)$ degrees, then normally from mirror $M_2$ and returns along its previous path to the dividing plane of the prism, where it recombines with beam 1. The observer at $E$ sees interference fringes on the superimposed images of the two mirrors.

The gross aspects of the fringe pattern (fringe direction and spacing) are controlled by the wedge angle between the wave fronts of beams 1 and 2, while the small irregularities of the fringe pattern are a function of the irregularities of the test surface. If the test surface were perfectly flat, the fringes would be straight and parallel. Any curvature of the test surface introduces a corresponding curvature in the wave front of beam 2. When this wave front is compared with the plane wave front of beam 1, curvature is introduced into the otherwise straight fringes. By adjusting the tilt of the test surface (that is setting $\beta = \theta$) and introducing a slight tilt across the width of the test area it is possible to adjust the fringes so that they run parallel to the long dimension of the test area (as, seen by the observer at $E$). In this case the curvature of the fringes is a direct and precise measure of the curvature of the test area (in its long dimension). The fringe pattern is a contour map of the area of the specimen surface that is being tested.

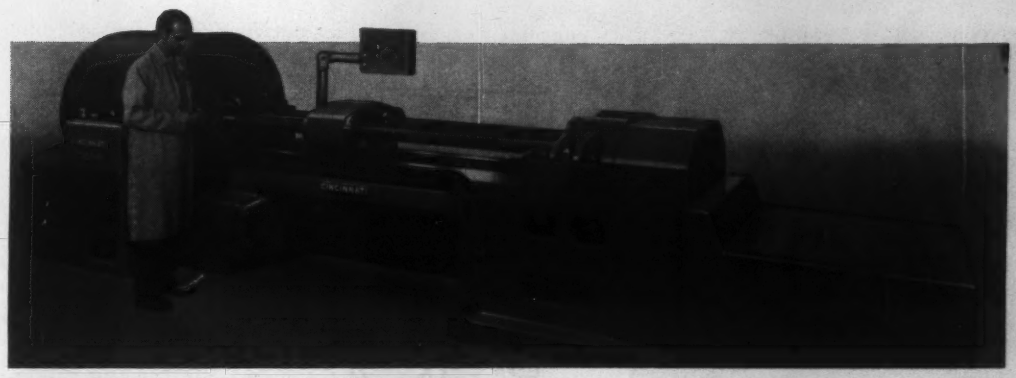
The sensitivity of the instrument depends upon the value of $\beta$. Since the light is reflected twice from the specimen surface, the sensitivity is double that obtained with the Linnik interferometer for the same angle of incidence. When the instrument is adjusted as described, one fringe departure from straightness corresponds to a departure from flatness of $\lambda/4 \sin \beta$, where $\lambda$ is the wave length of the light.

In a finished instrument the angles $\theta$ and $\beta$ could be made adjustable so that any length of surface could be made to fill the aperture of the system. This would give maximum sensitivity for any size surface measured. However, since the value of $\beta$ must be known for evaluating the fringe pattern, it may be more practical to use fixed values for $\theta$ and $\beta$ (with $M_1$ and $M_2$ bound into a rigid unit) and bind the mirror unit to the prism housing. This would eliminate the necessity of making frequent measurements of $\beta$ and also add stability to the instrument. The resultant instrument would have fewer adjustments and could be used by less skilled operators.

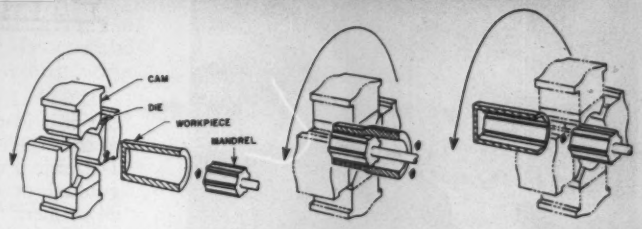
The maximum length of surface that may be covered with one setting is $A/\sin \beta$, where $A$ is the aperture of the prism. Thus, by decreasing $\beta$, any length surface could be covered with a prism of a given aperture, but of course the sensitivity of the instrument would also be decreased.

[1] V. P. Linnik, *Comptes Rendus (Doklady) de l'Academie des Sciences de l'URSS*, vol. 35, 1942, p. 16.

[2] Made from two 30-60-90-deg prisms cemented together to form an equilateral prism; one is partially silvered on the face opposite the 60-deg angle and becomes a semireflecting plane.



Four forming dies squeeze tubing against a mandrel more than 100 times a minute while revolving around the OD of the workpiece in the Intraform process. **At right,** mandrel is inserted intow orkpiece; diameter is reduced and internal profile formed in contact with rotating dies; completed workpiece is ejected and the mandrel retracted.




## Cold-Formed Tubular ID's

CYLINDRICAL WORKPIECES, such as tubes or rings, can be cold formed with a new machine to obtain profiles on the inside diameter. The machine made by Meta-Dynamics Division of The Cincinnati Milling Machine Company is called Intraform.

Four forming dies squeeze the tubing against the mandrel more than 1000 times a minute while revolving around the OD of the work. Dies are mounted on cams which contact a series of free-wheeling, hardened steel rollers located in the machine headstock. The top surface of the cam has the form of a sine curve, and at no time loses contact with the rollers.

At the completion of the operation, the profile of the mandrel has been reproduced in the ID of the part. Tensile strength can be improved as much as 30 per cent, and the continuous flow lines created in the profile formed area greatly add to fatigue life.

Intraform forming can be applied to any type of ferrous or nonferrous parts, ranging from about $^1/_8$ to 5 in. diam, and made from premachined blanks, tubing, castings, forgings, or extrusions. In addition to forming profiles in open or blind holes, laminated tubing can be made by form-bonding two or more metals. The bond is exceptionally strong and tight. Forming operations for which a mandrel is not required also may be performed on tubular and solid work. These include pointing, reduction of diameters, and forming of taper and radius.

Intraform Machines produce excellent finishes. Rifle barrels, for example, have a 32 microin. finish after drilling and reaming. After the Intraform operation which forms the rifling, the finish averages 7 to 8 microin. Accuracy, too, can be of the highest order. Some types of parts have been held to 0.0002-in. limits for the ID profile.

Quite often, less stock is required than for conventional machining since there is no loss in chips. A high-speed steel pin, for example, turned from stock $8^1/_2$ in. long, can be Intraform formed from $4^7/_8$-in. lengths.

This reduction in material required resulted in a saving of $202.65 per 700-piece lot. Furthermore, the Intraform reduced production time to less than half that previously required.

## Cooling-Tower Failures

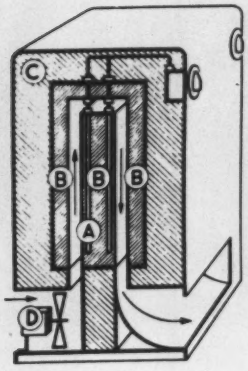
PREMATURE FAILURE of redwood cooling towers has been traced to the addition of chlorine to the circulating water. The addition of even small amounts has a deleterious effect on the ability of the wood to resist biological attack according to the results of an eight-year study by the California Redwood Association. These findings have been confirmed by independent research and field data. Chlorine appreciably accelerates the attack on softwoods by organisms of the soft-rot type. Further details may be obtained from the Technical Division, California Redwood Association, 576 Sacramento Street, San Francisco 11, Calif.

## Barge-Mounted Boiler

AN ORDINARY steam boiler mounted on a barge will be used to help speed up construction testing of secondary-system components for nuclear submarines at General Dynamics Corporation's Electric Boat Division yard along the Thames River in Groton, Conn.

For testing, the Babcock & Wilcox unit will be hooked up to the submarine by flexible steam connections and complete "shakedown" tests of the steam plant will be made just prior to installation of the reactor in the submarine.

The special control equipment required for the seagoing land-type boiler is being furnished by The Bailey Meter Company, of Cleveland, Ohio. To remove any possible hazard created by the presence of mercury, the regular mercury-containing instruments for the boiler will be replaced by special instrumentation. A new type of steam flowmeter is also being built by Bailey to help adapt the boiler for its unique assignment. Fired by a Babcock & Wilcox oil burner, the boiler will consume about 456 gal per hr of residential-type fuel oil.




Electrically heated blocks of compressed magnesite, B, surrounded by heavy insulation, C, store heat between 10 p.m. and 6 a.m. when power demand is low, and give it up during the day and evening. Units can be housed in the traditional tile ovens, left, or in modern radiator-coverlike cabinets. Operation is fully automatic, and circulating fans, D, are provided in some models.

## Storage "Oven" for Room Heating

STORAGE OVENS which are electrically heated at night when power demand is low and give up their heat as needed during the day and evening are being used for domestic space heating in Austria, Switzerland, and West Germany.

The daily heating requirement is absorbed between 10 p.m. and 6 a.m. and stored in blocks of compressed magnesite, chosen for its local availability and favorable materials constants. Mineral-wool insulation and a system of louvres insure the retention of the heat until needed. Any intensity and duration of hot air can be obtained to suit individual requirements—that is, maximum in the evening, uniform throughout the day or other variations as required.

Fully automatic operation with thermostatic controls is provided and hand regulation is also possible. Heating current is regulated as a function of the outside temperature. This is fully automatic except on days of sudden temperature change.

The details of the system are given in an article, "Elektrische Raumheizung mit Nachstrom-Speicheröfen," by Peter Borstelmann, Rheinisch-Westfällisches Elektrizitätswerk, in *Die Umschau*, vol. 58, 1958, pp. 724–725, and in 1958 World Power Conference Paper No. 71 H/3, "German Experience With Electric Storage Space Heating," by H. Masukowitz and W. Samwer.

Because of the higher cost of coal in Austria, nearly four or five times as many units have been installed in that country as in West Germany. In 1956 there were 125,000 installed in Austria and 29,000 in West Germany. First patent applications date from the 1920's.

Individual room units varying in appearance from cabinets resembling radiator covers to the traditional tile stoves furnish the outer covering of the insulated core with electric-heating elements and hot-air channels. Temperature of the core varies between 300 and 700 C (572 and 1292 F). Surface temperature of the outside of the unit is uniform at 70 C (158 F). Final temperature of the core can be adjusted within its variability limits. The time it takes to heat the core can also be adjusted for gradual or rapid warm-up. Louvres provide the only adjustment for the release of the heat.

A typical 3-kw model requires an average daily input of 24 kw, that is, 3 kw per hr during the 8-hr core-heating period. Daily output of that model is 585 watthr, or approximately 1987 Btu. The core storage space required is 10 to 15 cu ft per kw. About 65 to 85 kwhr of heat are required per day for each cubic meter of space to be heated. Units cost DM 185 per kilowatt (approximately $45).

The storage units help to equalize current demand in the winter when load conditions show the widest fluctuation, although the supply of cheap off-peak current has already been exhausted in some areas of Austria. The units would be even more important for equalizing demand where electricity is generated by nuclear fission because of the base-load character of such plants.

## Floating-Zone-Refining Improvement

A STRIKING IMPROVEMENT in the floating-zone-refining technique, substantially increasing the volume of material which can be purified, was described at the recent meeting of the American Physical Society in Cambridge, Mass., by W. G. Pfann, K. E. Benson, and D. W. Hagelbarger of Bell Telephone Laboratories. Paradoxically, the new technique also makes it possible to treat much thinner cross sections than has been feasible before.

The floating-zone technique has proved highly valuable in producing extreme purity in reactive metal and semiconductors, because the molten material is never in contact with a container. However, it has been limited until now to use with small amounts of material.

In conventional floating-zone refining (MECHANICAL ENGINEERING, October, 1957, pp. 954–955), a rod of the material to be purified is held in a vertical position, while a zone is melted by a heat source. The molten zone is held in place within the rod by its own surface tension. This zone is then made to move along the rod, and the impurities which collect in the molten material move to one end. The end is subsequently cut off before the material is fabricated into devices.

The primary limitation on the conventional method is

the fact that, for any given material, there is a maximum height of molten zone which can be supported by the surface tension. Small-diameter rods can be melted through easily without exceeding this maximum height. However, in larger diameters, by the time the rod has been melted through, the height of the zone has become so great that the surface tension can no longer hold the volume of molten material.

The new method gets around this difficulty by using specially shaped cross sections, such as flat plates and tubes. These shapes provide a cross section small enough in thickness to permit melting through without exceeding the maximum height, and large enough in width to increase the total cross-sectional area treated. The inventors have shown that molten zones in such shapes are surprisingly stable.

For example, it is almost impossible to produce a stable molten zone in a 1-in-diam iron rod, because the maximum height of the zone is generally exceeded during the heating required to melt through the rod. However, it is relatively easy to melt the entire cross section of a 2-in-diam, $^1/_8$-in-wall tube of the same material without exceeding this maximum height. The areas in both forms are the same.

Stable, wide molten zones have been maintained experimentally in one or both cross-sectional shapes, in materials such as silicon, iron, tin, gold, lead, and bismuth.

The new method works well at very small plate thicknesses in contrast to the rod floating-zone method, in which the maximum stable zone height decreases to zero as the rod diameter decreases. Such a decrease in maximum zone height can be avoided in the new method. Hence treatment of sheets in the order of mils or less in thickness becomes feasible.

It is expected that increases in cross-sectional areas at least five to ten times those currently used will be feasible. Also, this new wide-zone technique should make the floating-zone method applicable to materials for which the conventional method is not practical. It appears that this new technique will greatly enhance the utility of the floating-zone principle in the purification of reactive materials.

Both zone-refining techniques were discovered at the Bell Laboratories; the original technique by W. G. Pfann and the extension of the method by H. C. Theuerer.

A tubular sample of iron is positioned in an induction-heating coil for floating-zone-refining experiments

## Thermistor Monitoring for Bearings

A COMPREHENSIVE thermistor monitoring system for detecting incipient bearing damage in auxiliary powerhouse equipment is in operation at the Buffalo, N. Y., plant of National Aniline Division, Allied Chemical Corporation. Installed about six months ago, the overheat-detection system developed by Fenwal Inc., Ashland, Mass., covers a total of 84 points in two power plants and a river-water pumping station.

The bearing overtemperature monitoring system consists of 84 Fenwal thermistor detection units wired to an alarm system. Each detection unit is set to actuate when the bearing temperature rises to 30 F above the normal summer operating temperature.

The protected equipment includes all forced-draft fans, induced-draft fans, boiler feed pumps, and feedwater transfer pumps associated with National Aniline's five large-capacity steam boilers, plus four river-water pumps which handle up to 20 mgd of cooling water.

The detection system solves the problem of providing around-the-clock protection of essential equipment which is widely scattered at many unmanned locations in three plant areas. Savings in operating costs should pay for the system several times over in the first year.

Strips of plastic flexible magnets can be used as combination refrigerator gasket seals and locks and for numerous other applications

## Flexible Magnets

FLEXIBLE magnets made of Koroseal vinyl plastic specially compounded and processed to react exactly like metal or ceramic magnets have been announced by the B. F. Goodrich Industrial Products Company, a division of The B. F. Goodrich Company. The material can be produced in continuous lengths in an unlimited number of shapes ranging in size from fractions of an inch to several inches in diameter. It can be cut without impairing its magnetic qualities.

The material is attracted to ferrous metals or to itself. Unlike steel magnets, which can be magnetized only lengthwise with the "north" pole at one end and the "south" at the other, the new flexible magnet can be magnetized in any direction.

The company is currently producing the material for use in refrigerator gasket seals. The magnetic strip is used inside a flexible Koroseal gasket to form a perfect airtight seal around the entire perimeter of the refrigerator door and eliminates the need for a latch.

Demonstrating an exhaust-fumes analyzer, **left to right,** W. B. Yant of M-S-A; S. L. Hanauer, Mem. ASME, deputy commissioner, N. Y. City Dept. of Air Pollution Control; and Leonard Greenburg, commissioner

## Exhaust-Fumes Analyzer

AN INSTRUMENT which provides continuous, accurate measurements of CO and other exhaust contaminants directly at the source, is aiding research on the relation of auto-exhaust fumes to air pollution. The instrument is capable of direct measurement of CO in concentrations as low as 1 ppm. Other unburned products from automobile exhausts can be measured with the same precision.

Mine Safety Appliances Company, Pittsburgh, Pa., has developed the instrument called the M-S-A Lira infrared analyzer. The analyzer employs two infrared beams. One beam passes through a cell containing the polluted air sample; the other passes through a comparison cell. Any deviations caused by the presence of the pollutant are electrically converted into a highly precise measurement of the concentration of the contaminant.

Morris B. Jacobs, director of laboratory, New York City Department of Air Pollution, reported that the Lira analyzer was used on daily tests in two selected areas. The first test station was set up at street level at the Manhattan end of the Queensboro Bridge, New York, N. Y., in a zone of heavy traffic. A second was located in an area of medium motor-vehicle traffic.

The test sites were selected because the atmosphere is representative of the type of air breathed by the city dweller. The Lira analyzer made it possible to measure continuously the extent of air pollution caused by CO and hydrocarbons from exhaust fumes—with respect both to pedestrians and motorists.

Results of the first series showed that concentrations of contaminants found at street level were three to four times higher than those detected at the higher test station. Peak contaminations corresponded with the rate of traffic density, 6 to 10 a.m., and 5 to 8 p.m.

## Impregnation of Iron-Powder Parts

MANY of the parts made from iron powder by powder-metallurgy techniques must meet requirements for corrosion resistance and pressure tightness. These requirements make it desirable to eliminate porosity.

Unfortunately, the newer techniques of repressing and heat-treating interfere with plastic impregnation if conventional impregnating techniques are used.

Using a special technique developed after considerable study, engineers at Metaseal American Corporation, West New York, N. J., have solved the problem of impregnating iron-powder parts which must be heat-treated to increase their strength and hardness. Since it is impossible to successfully impregnate such parts because of the film of quenching oil which clings tenaciously in the pores of the part, Metaseal uses a special process, which is applied prior to the heat-treating operation. This new technique involves impregnating the parts with the Metaseal polyester impregnant, which is then converted to a carbonized residue by a "burning-out" process. The parts are then subjected to normal heat-treating techniques. The residue remains in the pores, and acts in the same manner as the conventional polyester impregnant to prevent salt entrapment during electroplating.

In addition to making possible excellent electroplates and pressure-tight structures, plastic impregnation improves machineability of metal-powder parts. Parts that have been impregnated can be easily sized, reamed, or machined to a fine microfinish with sizable savings in production time. Using this technique, Metaseal engineers have successfully sealed over 3.5 million metal-powder parts.

## Boilers to Thaw Seaway Locks

FOUR 40-hp mobile package boilers costing about $20,000 and manufactured by the Cleaver-Brooks Company, Milwaukee, Wis., will be used to thaw ice on the locks of the St. Lawrence Seaway.

Canvas covers will form enclosures in which unit heaters will maintain 70-deg temperatures with −10 F ambient.

The boilers, mounted on hard rubber wheels for portability, will be pulled into position and will feed steam at the rate of 1200 lb per hr to the unit heaters and to a steam gun which the operating crew can use to blanket the lock surface.

The resulting blanket of steam and warm air will thaw the ice collected on the gate's surface, freeing the gate for action.

During the summer, the boilers will be used for steam cleaning of the locks, gates, machinery, and other equipment subjected to oil accumulation.

After plastic impregnation, a pump impeller made from iron powder is pressuretight at 74 psi

## Food-Irradiation Facility

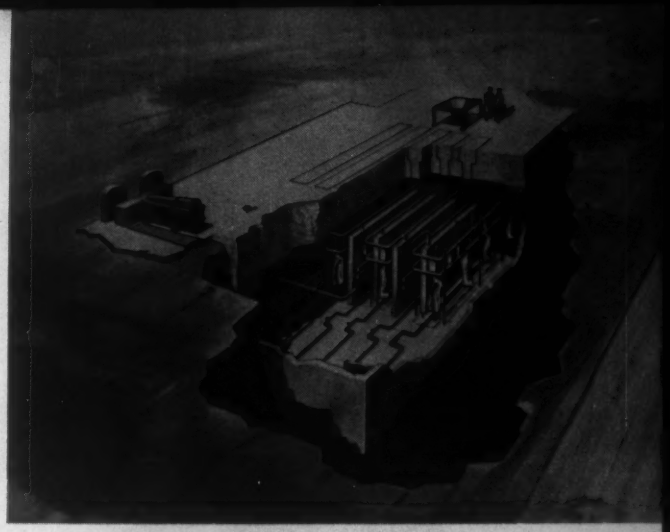
A FOOD-IRRADIATION facility has been approved by the AEC for possible future construction as part of the Sodium Graphite Reactor power plant. The nuclear plant is being built for the Consumers Public Power District in Hallam, Neb., by Atomics International, a division of North American Aviation, Inc.

Radioactive sodium coolant would be used as the source material for preserving and sterilizing food and processing related materials by exposure to radiation.

The facility would be equipped to process a wide variety of foods, such as meat, potatoes, onions, and beets. Operating capacity, as estimated in the design study, would be about 520 tons per day, irradiating various forms of foods sufficiently to offer limited preservation.

Material to be processed would pass by rectangular "slabs" containing the radioactive-sodium source and would be exposed to gamma rays.

Both military and industrial organizations have studied the applicability of radiation processing for food. Atomics International carried out an analysis of food-irradiation methods for the Army's Quartermaster Corps in 1956 to determine the most practical means of treating food in this manner.



Meat, potatoes, onions, and beets would be a few of the foods irradiated for preservation and sterilization in a facility to be added later to the Sodium Deuterium Reactor

Reports indicate that no toxic effects have resulted from consumption of radiation-sterilized foods by humans. Radiation can completely eliminate infestation in such products as grain and increase the shelf-life of refrigerated fresh meat as much as five times.

## Nuclear Briefs

### ▶ Fast Breeder With Oxide Fuel Cycle

THE Atomic Energy Commission has selected as a basis for contract negotiations the proposal of the General Electric Company, San Jose, Calif., for performance of the research, development, and design of a fast-breeder reactor using a plutonium-oxide, uranium-oxide fuel cycle.

A cost-type contract will be awarded for the work which is expected to cost about $500,000 and require 18 months for completion. The objective of the project is to lower the cost of electric power from fast-breeder-reactor power stations, primarily by reducing fuel-cycle costs.

### ▶ TREAT Achieves Criticality

The Transient Reactor Test Facility, TREAT, a nuclear reactor designed to produce short, extreme pulses of nuclear energy—resulting in high temperatures—has achieved criticality. The derived heat from the reactor located at the Argonne National Laboratory, section of the AEC's National Reactor Testing Station, near Idaho Falls, Idaho, will be sufficient to permit meltdown studies of samples of fuel elements and components intended for use in fast reactors, as well as irradiation studies.

The reactor is fueled with uranium oxide uniformly dispersed in graphite moderator. Transient pulses in this reactor are believed to be of greater intensity than those which can be safely attained in any other nuclear reactor.

### ▶ 1000-Emw Plant Added to U.K. Program

The British Central Electricity Generating Board, CEGB, is planning a 1000-emw nuclear power station at Oldbury-on-Severn in the west of England, near Bristol, and about $4^1/_2$ miles downstream from the nuclear station under construction at Berkeley, according to the *Forum Memo* of the Atomic Industrial Forum, Inc. Advantage will be taken of a rock shelf offshore to create an artificial tidal reservoir. Large quantities of water will be drawn from the reservoir for cooling the condensers of the steam turbines during low-tide periods. This unusual arrangement will reduce the costs that would normally be incurred in obtaining cooling water from an estuary with as wide a tidal range as the Severn.

Three other sites in the vicinity are also being examined for suitability for future power plants, at Tidenham, Aust, and Portskewett.

The 1000-emw size of the station, which presumably will have two reactors, would make the plant the largest now planned anywhere in the world. Other CEGB plants are now under construction at Bradwell, Berkeley, and Hinkley Point. Preliminary work has begun at Trawsfynydd, Wales, with a contract to be awarded for major construction later in the year. Plans have been made for sites at Dungeness in Kent, and Sizewell in Suffolk. Nuclear power stations already in operation at Calder Hall and Chapelcross are owned by the U. K. Atomic Energy Authority rather than by the CEGB, and the Hunterston station under construction in Scotland is owned by the South of Scotland Electricity Board. Hunterston station had been delayed an approximate six months by labor difficulties.

### ▶ Chapelcross Generating Electricity

The first of four reactors at the Chapelcross nuclear power station near Annan, Dumfriesshire, Scotland, fed electricity into the National Grid in February, and the station was officially opened in May. Chapelcross, built by the United Kingdom Atomic Energy Authority, produces both plutonium and electricity and will have a generating capacity of 184 mw when all four reactors are completed.

**Fuel Elements.** Pebbles for the high-temperature gas-cooled reactor which Sanderson & Porter is developing for the AEC. Graphite moderator is incorporated with the ceramic fuel to permit 1450-psi 1000-F steam conditions. The easy-to-manufacture ball-shaped fuel elements do not require precise location or support, and are simply poured into the bed of the reactor.

# PHOTO BRIEFS

**1 Machining Honeycomb Structures.** No filler is needed to make the honeycomb-core material rigid in the machining method developed by Martin's Baltimore Division. A standard three-axis-controlled cutting machine, equipped with a newly designed portable head and a modified stylus, is able to convert the cutting to a five-axis operation. The stylus has five pickup points and rides the surface of a wooden or plaster contoured model, and transmits rise, fall, and tilt motions to the cutter head by a combination of pneumatic, hydraulic, and electronic components. Both concave and convex compound-contour honeycomb-core sections are accurately produced.

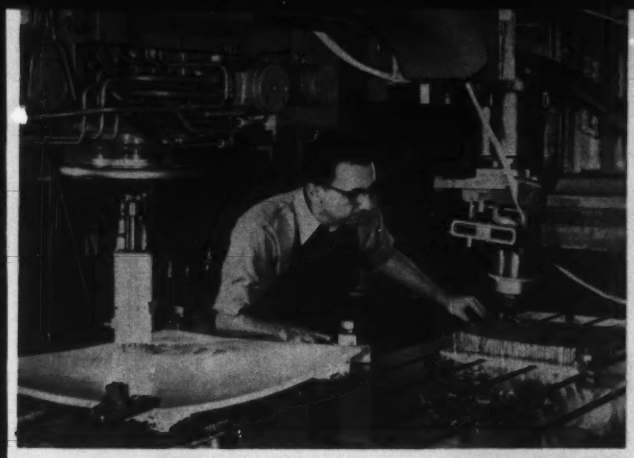
**2 Gas-Fired Heat-Treating.** A luminous-wall combustion system developed by A. F. Holden Company, Detroit metallurgists, can heat workpieces during reforming operations to near melting point. There is no direct exposure to fire to cause parts to harden and warp. Diaphragms are heated to 1950 F; guide vanes to 950 F.

**3 500,000-Hp Power Plant.** Designed and built by Reaction Motors Division of Thiokol for the X-15, it develops 50,000 lb of thrust and will propel the first manned aircraft 100 miles into space at better than 4000 mph. Safety, the most significant factor in this liquid rocket engine's operation, requires that the engine be able to start, throttle, shut down, and restart without endangering the pilot under any single malfunction. This necessitated controls, sensing devices, and other equipment that would keep the pilot informed of engine operation and automatically place the engine in safe condition in event of a malfunction.

**4 Pyroceram Journal Bearings.** Glass-ceramic journal bearings produced by Corning Glass Works and operating with various metal shafts resist all tendency to weld or score even in the highly corrosive fluids encountered in some chemical and food-processing applications.

**5 Standard Samples.** Rust and discoloration are avoided by using three-dimensional photographic transparencies on a continuous roll to provide standard samples for visual inspectors. The Timken Roller Bearing Company uses them to indicate maximum passable defects for the cups, cones, cages, and rollers of bearings.

**6 Multipurpose Missile Handler.** Self-loading truck, towing tractor, and a crane were combined by the Michigan firm, Clark Equipment Company. Called "Telefork 102," it would replace several single-purpose machines now used. The front end converts from crane to forks for carrying packaged missile components through sand, snow, or water.



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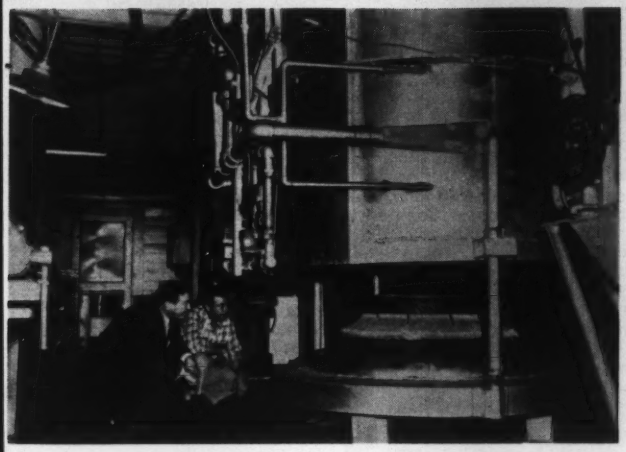
More photo briefs on next page ▶



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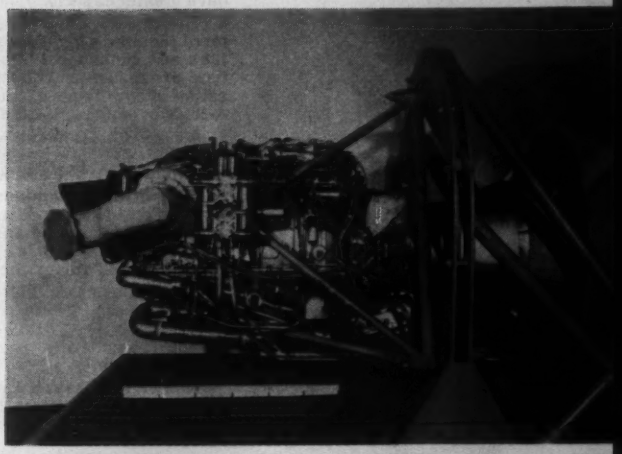

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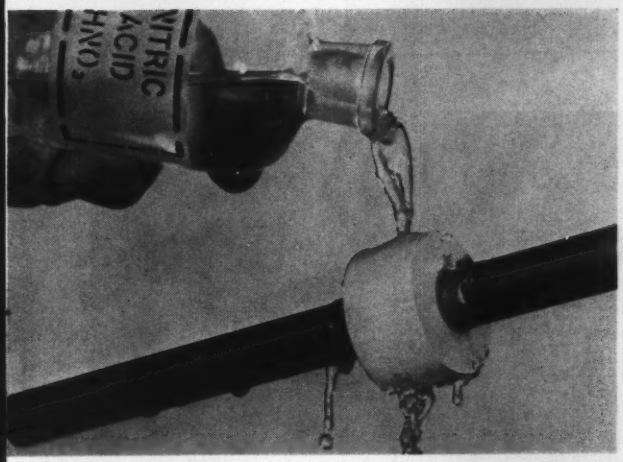


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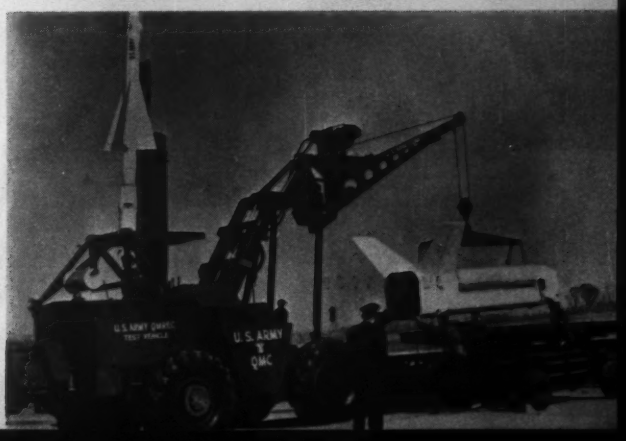


MECHANICAL ENGINEERING

PHOTO BRIEFS

# .... A look at the GIANTS

**7 Hydro Generator Shaft.** Westinghouse used a 96-in. engine lathe to machine this 50-in-shank-diam shaft for the first of 13 15-ton, 167,000-kva waterwheel generators for the $720-million Niagara project of the N. Y. State Power Authority. Only Grand Coulee Dam will have greater capacity in the U. S.

**8 Thermal-Expansion Bellows.** A 900-F temperature rise in the Sodium Reactor Experiment required a gas-tight seal and provision for 2 in. of thermal expansion of the reactor core tank and outer tank. Zallea Brothers, Wilmington, Del., constructed an 11-ft-ID bellows-type expansion joint for the core tank, and a $12\frac{1}{2}$-ft-ID one for the outer tank. Type 321 stainless with type 304 welding nipples was used for the core bellows; type 310 with ASTM A-301 Grade B alloy-steel welding nipples for the outer bellows.

**9 A 60,850-Lb Crankshaft.** It will be used on an 1800-ton pipe-extrusion press and required 120,000 lb of counterweights for machining at United States Steel. The small crankshaft is for a model airplane and weighs 0.44 oz.

**10 Evaporator.** Tandem tube bundles were used in a 65-ft-long, 87,000-lb evaporator for the Indian Point Nuclear Plant made by the Griscom-Russell Company, Massillon, Ohio. The 110-psia 750-F steam extracted from the turbine will produce 65,000 lb per hr of vapor at 62 psia. The water, with only 0.25 ppm of impurities, will be converted to steam in a nuclear-reactor-heated steam generator to produce 275 emw for Consolidated Edison.

**11 Scroll Case.** An 18-ft-diam-inlet, 56-ft-across scroll case is being assembled to the stay ring of one of 12 reversible pump-turbines being built by Allis-Chalmers for the N. Y. State Power Authority's Tuscarora plant. As a 37,500-hp motor-driven pump, each unit will deliver 3400 cfm against a storage-pond head of 85 ft. Each unit is rated 28,000 hp at 75 ft head as a turbine, and in reverse rotation will become a 25,000-kva, 8-power-factor generating unit.

**12 Speed Increaser.** Final inspection is performed on the Westinghouse gearing unit for a 15,000-hp centrifugal gas compressor for installation on the Texas Eastern Transmission Corporation's natural-gas pipeline.

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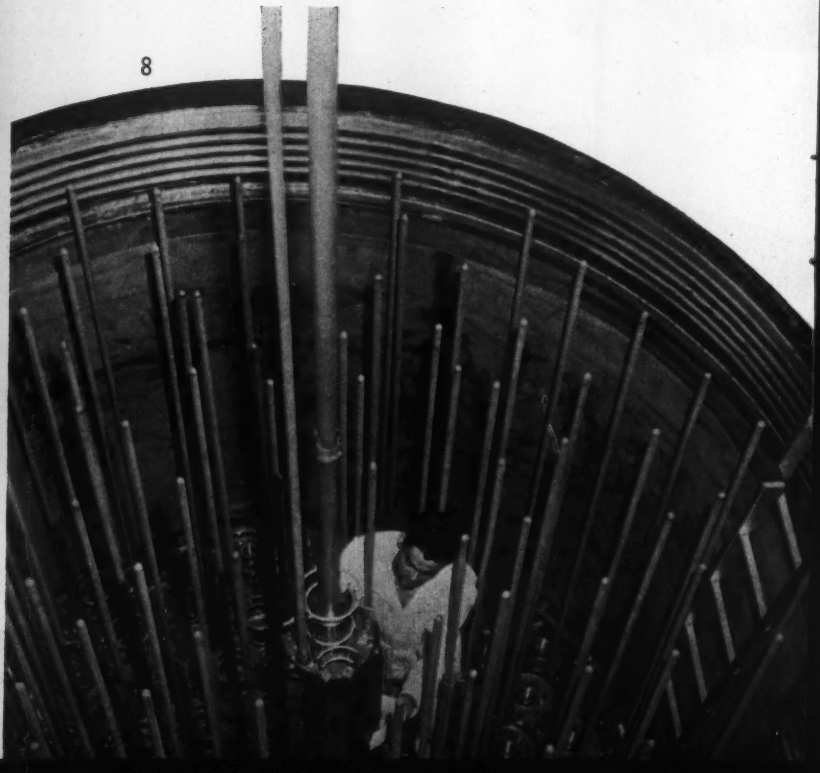

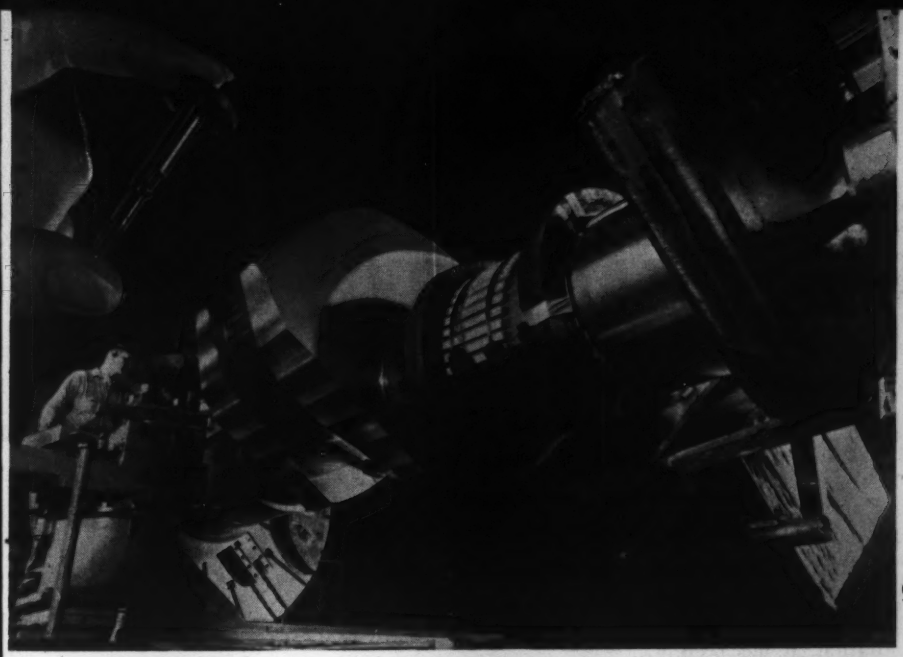

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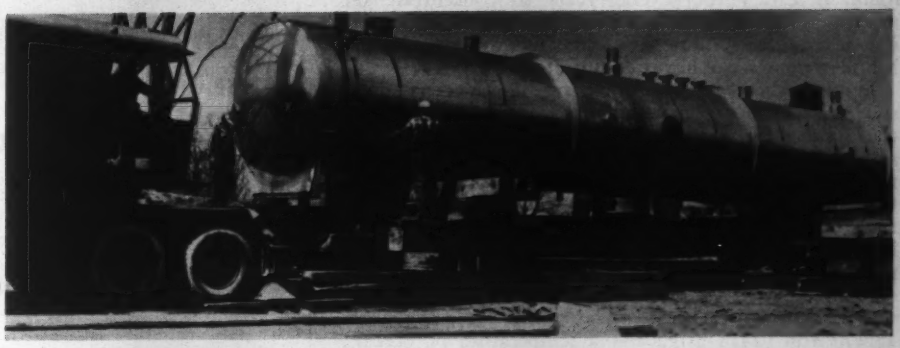

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Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

# EUROPEAN SURVEY

## Swiss Industries Fair

THOUGH the weather was somewhat unkind to the 43rd Swiss Industries Fair, held in Basel, Switzerland, April 11–21, it was visited by some 735,000 people—a sufficiently remarkable total, considering the limitations of the site, which offers no opportunity for expansion of its ground plan. Because of this limitation, it has been found necessary for several years to concentrate on machine tools and textiles alternately, but, though 1959 is a textile year, room was found for a number of exhibits in the class of heavy engineering.

In one of these, the plant for a large new electric power station at Baudour, in Belgium, advantage was taken of the fact that the stands of Sulzer Brothers, of Winterthur, and Escher Wyss, Ltd., of Zürich, were closely adjoining to make a combined display. Sulzer Brothers showed the lower part of the combustion chamber of the monotube boiler that they are supplying to Baudour, and Escher Wyss exhibited a scale model of the complete plant, for which they are providing the turbines, generator, and auxiliary machinery. The boiler is designed to evaporate 748,000 pph of water, delivering the steam at 170 atm (2418 psig) and a temperature of 1112 F. There are high, medium, and low-pressure turbines, driving a generator with an output of 115,000 kw. The design of the plant is in the hands of the Compagnie Générale d'Entreprises Electriques et Industrielles, of Brussels.

## Oil Pipelines in Europe

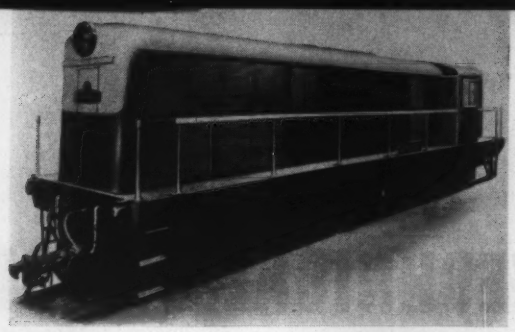
FOR several months now, Germany has had in operation an underground pipeline 27 in. bore and 240 miles long for the delivery of crude oil from the port of Wilhelmshaven to the refineries in the Rhine-Ruhr district. It was constructed jointly by two German organizations, the Mannesmann Rohrleitungsbau and the Vereinigter Rohrleitungsbau, and contains 60,000 tons of piping. Siphons had to be constructed under 13 river beds and other channels, that in the Rhine near Cologne being buried 13 ft below the bed of the river. At present only one pumping station is operating, at Wilhelmshaven, and this delivers the oil at Cologne in $4\frac{1}{2}$ days, a velocity of about 2 mph; but boosting stations are being constructed or are planned at Östenwalde, Ochtrup, and Mulheim, and these, when completed, will increase the velocity to about $5\frac{1}{2}$ mph and raise the annual capacity of the line from 9 to 22 million tons. Another pipeline, now approaching completion, is being laid in Holland, from a point near Rotterdam, where the Pernis refinery of the Royal Dutch-Sheel companies is situated, to Godorf, a town on the Rhine between Bonn and Keulen. The first 155 km (100 miles), i.e., as far as Venlo, on the Dutch-German frontier, is 24 in. bore. From Venlo to Godorf, a distance of 85 km (53 miles), the bore is 27 in. The scheme also includes a 24 in. line from Venlo to Wesel, on the Rhine, a distance of 40 km (25 miles). This system is being constructed to the order of a Dutch company, the N. V. Rotterdam-Rijn Pijpleiding Maatschappij. An extension 16 in. bore is projected, eastward from Wesel to Gelsenkirchen.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

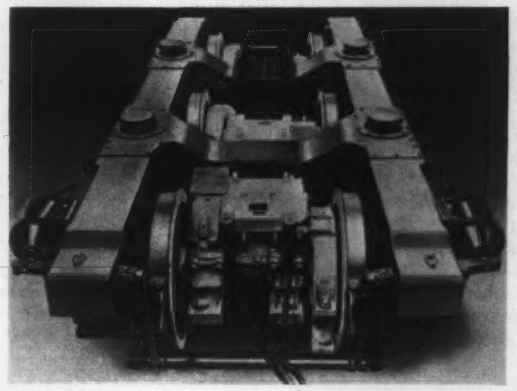
## Udex Unit at Stanlow Oil Refinery

THE STANLOW oil refinery, near Ellesmere Port, England, one of the four plants in the United Kingdom owned by the Shell Petroleum Company and its associates, which covers nearly three square miles in extent, has recently put through its acceptance trials a Udex unit designed by the Universal Oil Products Company of Des Plaines, Ill., costing about $\$2\frac{1}{2}$ million. It comprises six columns, the tallest being a 120-ft solvent stripper, and has a capacity of 1000 tons a day. The unit is of the solvent extraction type, using a special solvent mixture of diethylene glycol, dipropylene glycol, and water. The feedstock, which is a product of the Stanlow platformer, will be extracted with this glycol mixture, which preferentially dissolves the aromatic components. The aromatic extract is distilled off from the solvent and is used in aviation gasoline, while the insoluble nonaromatic portion or raffinate will be used as an additional feedstock for other processes. The plant is the first of its kind in any Shell refinery.

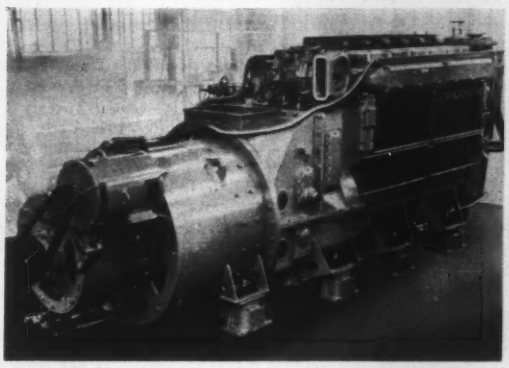
**Udex unit in operation at Shell Oil's Stanlow Refinery at Ellesmere Port, near Chester, England, produces important aviation gasoline blending components**



British Thomson-Houston diesel-electric locomotive with Lister-Blackstone "Twin-Bank" engine, *top*



Bogie, *center*, complete with traction motors, for diesel-electric locomotive has 12-ft wheelbase, total wheelbase is 36 ft



Lister-Blackstone "Twin-Bank" engine and British Thomson-Houston generator, *bottom*. Overhung auxiliary generator and exciter driven by V-belt are shown.

## Diesel-Electric Locomotive

In the "European Survey" for December, 1957, p. 1159, a description was given of a "Twin-Bank" diesel engine, in which two sets of cylinders, arranged side by side on one bedplate, drive parallel crankshafts which are connected by gearing to a single output shaft; it was developed by Blackstone & Company, of Stamford, England, with whom are associated another English oil-engine firm, R. A. Lister and Company, of Dursley. A power unit of this type has now been applied to drive a new type of diesel-electric locomotive by the British Thomson-Houston Company, of Rugby, England, who have supplied the electric generator and other equipment.

The locomotive is intended for use on the lighter kind of railway in overseas territories, many of them in the tropics, where freight forms a large part of the traffic, and of less than the standard gage of 4 ft $8\frac{1}{2}$ in., so that axle loadings are restricted.

The design provides for maintaining the maximum engine output of 1100 hp in an ambient temperature of 120 F at sea level, or up to an altitude of 4000 ft with an ambient temperature of 80 to 85 F. The engine is a Lister-Blackstone Type ERS.12T and has two banks of six cylinders. It operates on the four-stroke cycle and is exhaust turbocharged. The crankshaft speed is 800 rpm at the full output of 1100 hp and the idling speed is 350 rmp. Each crankshaft has a small flywheel. The drive is taken through hardened and ground spur gears to the generator shaft, which makes 1320 rpm for the 800 rpm of the crankshafts. The Blackstone type of flexible coupling and nodal damper is fitted between the crankshafts and the generator, and hydraulic dampers are provided to prevent harmful torsional vibrations in the individual crankshafts. The engine bed, which is common to both sets of cylinders, is of fabricated steel, extended at one end to form the lower part of the gearbox. The cylinders have cast-iron liners and aluminum-alloy pistons. The governor gear is linked to the two fuel pump lines to insure that both banks of cylinders are balanced in power output at all speeds and loads, and is arranged to stop the engine automatically if the speed rises by more than 10 per cent above the normal 800 rpm or if the lubricating oil pressure falls below 10 psi.

The main generator is a 10-pole machine, fan-cooled, and having all connections to the windings brazed, to withstand heavy overload conditions. The 8-pole shunt-wound auxiliary generator is built on the same shaft as the traction generator and is rated at 110 v, 48 kw, at 700 to 1125 rpm. The traction motors are axle-suspended, with a single-reduction drive to the axle. The maximum tractive effort is 42,000 lb (24,000 lb at the continuous rating of the motors) and the maximum speed is 55 mph. The minimum weight of the locomotive is 72 long tons and the minimum axle loading 12 tons, which can be increased to 14 tons if needed. In the design particular attention has been paid to adaptability to different rail gages with the least possible alteration to the basic structure; the prototype has been built to meter gage, but can be readily altered to suit 3 ft 6 in. gage; and the power unit and superstructure can be fitted equally well to underframes designed for standard gage or wider, up to a maximum of 5 ft 6 in. The maximum length over headstocks is 49 ft, and the height and width 12 ft 9 in. and 9 ft 9 in., respectively. The wheels are $36\frac{1}{2}$ in. in diam, the bogie wheelbase is 12 ft, and the total wheelbase 36 ft. The locomotive will work over curves of 300 ft radius minimum. The fuel capacity is 500 gal and water 50 gal. For trial purposes, it is being shipped to East Africa, to run on a particularly heavy section of the system of the East African Railways and Harbours Board, with steep gradients, tight curves, and climatic conditions of exceptional severity.

# ASME TECHNICAL DIGEST

## Aviation/Space

**Environmental Control Systems for Manned Space Vehicles..... .....59—Av-11**

By R. A. Nau, Assoc. Mem. ASME, Convair—A Division of General Dynamics Corporation, San Diego, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

In manned space flight, the engineer must provide, as well as control, the environment required for the comfort of the human occupants of the space-vehicle cabin. For flights of more than a few passes around the earth, the problem of supplying this atmosphere has a major influence on the design of the vehicle system, since with techniques and equipment available today, the environmental control system may well represent a major part of the system payload.

Therefore the purpose of this paper is to present and compare some of the methods at our disposal for providing a livable environment for the early space traveler and to indicate the magnitude of the systems design problem involved.

Three factors stand out in differentiating the space environmental-control situation from those of similar nature in high-altitude manned aircraft and balloons: (*a*) The near-vacuum surroundings imply that all heat exchange between the vehicle and its surroundings is by radiation only; (*b*) there can be no "bail-out" in event of equipment failure since sufficient kinetic energy exists to vaporize the escapee on re-entry into the earth's atmosphere, even in the best of space suits; and (*c*) the absence of gravity effects and the resulting complications to equipment design.

**Artificial "G" Fields—Perception of the Vertical.....59—Av-8**

By J. T. Ray, Lockheed Aircraft Corporation, Marietta, Ga. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

One of the problems associated with manned-satellite operations is that of man's ability to maintain his orientation in space, particularly with regard to visual and postural cues.

Visual cues, of course, arise from stimulations of the sensors of the eye. Receptors providing postural cues are more difficult to define. The most significant of these, however, are known to be the receptors of the skin, viscera, musculoskeletal system, and the vestibular mechanism of the inner ear.

The experimental problem investigated in this paper is concerned with the effect that translation and rotation of the vestibular mechanism of the inner ear has upon the index of adaptation to tilt. The term "adaptation to tilt" refers to the constant error of adjustment to the gravitational vertical which results from an individual being placed in a position of tilt and returning himself to that position which feels upright.

The manner in which the adaptation effect is distributed with respect to repeated trials (termed habituation), the degree to which the habituation effect can be transferred to the opposite quadrant, and the retention of habituation over a period of time are also treated.

**Human Factors Design Requirements for Manned-Satellite Vehicles—A Survey of Equipment Requirements.....59—Av-14**

By H. L. Wolbers, Douglas Aircraft Company, Inc., El Segundo, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Man is linked to a man-machine system in three ways: (*a*) by his information inputs (display systems); (*b*) his information outputs (control systems); and (*c*) his physical working environment.

In the design of manned-satellite systems, the human-factors requirements for each of these areas must be specified. Inasmuch as time of operation is the critical dimension, design recommendations must be tempered by flight duration. For short periods, storage of man's gaseous, liquid, and solid needs will be sufficient. Furthermore, personal equipment items will probably not differ radically from currently existing requirements of long-range manned-weapons systems.

As flight durations increase, those items imposing the greatest weight and space penalty (food, water, waste, and oxygen) will be replaced with regeneration systems.

Weights, volumes, and power requirements are estimated for the systems required to provide the various human demands. These are presented as a function of time of flight.

**Psychophysiologically Centered Space-Vehicle Design..59—Av-13**

By A. J. Cacioppo, Goodyear Aircraft Corporation, Akron, Ohio. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Man's major function in space, at least in early space vehicles, will be that of collecting military and scientific intelligence and, as an operator, providing vehicle control and guidance (navigation).

Space-vehicle design, therefore, must be oriented by psychophysiological research findings to data that are meaningful to the design engineer.

In assessing the problem areas associated with space flight, the following were among those requiring immediate human-factors analysis and evaluation: Man's function in space; vehicle design, including both launch and orbiting of satellite vehicles; ground-support equipment; maintenance; and training. The first two of these areas are emphasized in this paper.

**The Nuclear Submarine As a Manned-Satellite Laboratory..... .....59—Av-9**

By A. E. Hickey, Jr., Electric Boat Division, General Dynamics Corporation, Groton, Conn. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

The functional similarity of prolonged

submarine missions to manned-satellite flights makes it possible to anticipate some of the research and development requirements for satellite operations. Most of the similarities occur at the system operational level of analysis, particularly the integration of the human operator and the control task.

Several submarine research projects are outlined. The research stems from requirements for atmosphere regeneration, chronic reliability and maintenance, simulation for training, display of uncertain information, and surveillance.

### Designing for Human Capabilities Under Acceleration in Satellite Operations.....59—Av-34

By R. C. Kaehler and J. P. Meehan, University of Southern California, Los Angeles, Calif.; and Toby Freedman, North American Aviation Inc., Canoga Park, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

With recent and anticipated technical developments in the field of rocket propulsion, a great deal of consideration is being given to the many problems of successfully placing a human into orbit and returning him safely to the earth's surface. One of the problems encountered in the manned-space flight is the prediction of human capabilities under relatively high magnitude long-duration accelerations.

There are two human capabilities which the designer of orbital vehicles must consider with respect to the acceleration problem: (*A*) The psychological capability of the crew which includes proper performance of such duties as data processing, navigation, communication, control functions, and the like; and (*B*) the physiological aspects of tolerance to the predicted acceleration forces. Both of the parameters must be considered in terms of (*a*) direction, (*b*) magnitude, (*c*) duration, and (*d*) rate of build-up of the accelerative force.

In general, there are four major types of accelerations of concern in the study of human capabilities: (*a*) positive, (*b*) negative, (*c*) negative transverse, and (*d*) positive transverse.

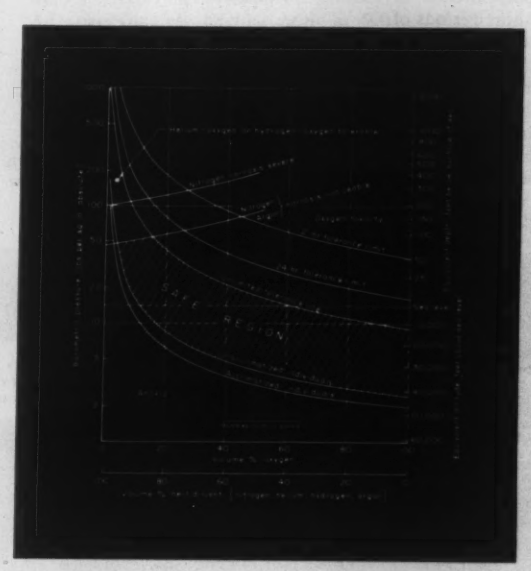
Each of these is discussed in this paper with respect to the two aspects of physiological and psychological capabilities.

### Environmental Requirements for Extended Occupancy of Manned Satellites.....59—Av-12

By S. H. Dole, The Rand Corporation, Santa Monica, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Environmental conditions that must be maintained within a manned satellite are similar, in most respects, to the conditions required by human beings on the earth's surface, but with this major difference: The human occupant of an earth satellite will be completely dependent upon the excellence of the engineering incorporated into the design and construction of the systems that he is using. In other words, the environment will be, to a degree never before attempted, entirely artificial.

An understanding of the extremes in environmental conditions that man is able to tolerate will enable us better to appreciate the limits within which we are working. In order to describe these extremes quantitatively, data were collected from a large number of sources in the literatures of aviation medicine, submarine and deep-sea-diving medicine, and studies of human performance under natural and artificial arctic, tropical, and desert conditions. These data were compiled and are here presented as "human time-tolerance" curves which represent the approximate operational limits of normal healthy adult human beings with respect to the major elements in the environment. Such curves can supply us with a guide to delimit the tolerable variations in the environment



**Man's respiratory requirements expressed in terms of total pressure and atmospheric composition (59—Av-12)**

METABOLIC DATA ON MAN (WHITLOCK)

| SUBSTANCE | INPUT-LBS DAY | OUTPUT-LBS DAY | |
|---|---|---|---|
| OXYGEN | 2.0 | | |
| CARBON DIOXIDE | | | 2.2 |
| FOOD | 1.5 | FECAL SOLID | 0.2 |
| WATER * | 4.8 | | 5.5 |
| IN FOOD | (2.6) | VAPOR | (1.9) |
| IN DRINKS | (2.2) | SWEAT | (1.1) |
| | | EXPIRED AIR | (0.8) |
| | | LIQUID | (3.6) |
| | | URINE | (3.3) |
| | | FECAL WATER | (0.3) |
| HEAT OUTPUT 12,000 BTU/DAY | | | |
| TOTALS | 8.3** | | 7.9 |

* 0.7 LBS DAY OF WATER FORMED IN FOOD METABOLISM (STRUGHOLD)
** GROWTH & MATTER LOSSES ACCOUNT FOR HIGHER INTAKE

ENVIRONMENTAL REQUIREMENTS FOR MAN

| ITEM | REQUIREMENT |
|---|---|
| OXYGEN | PARTIAL PRESSURE BETWEEN 2.8 &5.6 PSI |
| CARBON DIOXIDE | PARTIAL PRESSURE LESS THAN 0.1 PSI (1 S.L.) |
| HUMIDITY | WATER VAPOR PRESSURE, 015 TO 30 PSI |
| TEMPERATURE | 70-80 F |
| INERT GAS | PARTIAL PRESSURE BETWEEN 0 & 10.0 PSI |
| (NITROGEN, HELIUM) | |
| TOXIC & NOXIOUS ODORS | MINIMUM |
| TOTAL HEAT REMOVAL | 12,000 BTU/DAY |
| WATER VAPOR REMOVAL | 1.9 LB/DAY |
| LIQUID WASTE REMOVAL, RECLAMATION, OR STORAGE | |
| URINE | 3.3 LB/DAY |
| FECAL WATER | 0.3 LB/DAY |
| SOLID WASTE REMOVAL, RECLAMATION, OR STORAGE | 0.2 LB/DAY |

CARBON DIOXIDE REMOVAL METHODS

| METHOD OF REMOVAL | PENALTY PER MAN-HOUR WEIGHT-LB. | VOLUME-CU. FT. |
|---|---|---|
| 1. OVERBOARD VENTING | | |
| a. 14.7 PSIA IN CABIN | 27.0 ♣ | 0.83 |
| b. 5.0 PSIA $O_2$ IN CABIN | 9.2 ♣ | 0.27 |
| 2. ABSORPTION | | |
| a. LITHIUM HYDROXIDE | 0.123 | 0.0044 |
| b. BARALYME | 0.183 | 0.0032 |
| c. SODA LIME | 0.267 | 0.0053 |
| d. POTASSIUM SUPER OXIDE | 0.367 | |
| 3. FREEZE OUT | | |
| 4. REGENERATION (ALGAE) | • | 80 * |

♣ WILL ALSO REMOVE WATER VAPOR
• 80 CU. FT. PER MAN-UNIT+10 H.P. OF ELECTRICAL POWER

5. CALCIUM OXIDE REGENERATION 44
REQUIRES 1300 W. OF POWER

which must be maintained within a manned satellite during flight.

By environment is meant specifically the following: Composition and pressure of the atmosphere; gravitational forces (acceleration); temperature; radiation.

These are the primary elements in the environment that have an immediate bearing on the health and well-being of the man. Of course, there are other factors such as noise and vibration during take-off and landing phases, possible hazards from extraneous toxic substances, nutritional requirements, problems due to confinement and isolation, and the like; but these are not discussed here.

**Research on Human Performance During Zero Gravity...59—Av-10**

By E. L. Brown (Captain), Wright Air Development Center, Dayton, Ohio. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

At Wright Air Development Center, the Aero Medical Laboratory is using a Convair C-131B transport aircraft in experiments on effects of short periods of zero gravity on human performance and behavior.

The most important modification which has been found necessary to equip the C-131B for zero-gravity flights is the installation of a special pitch-lock mechanism to the propellers. The mechanism is designed to prevent the propellers from overspeeding when the engine oil pressure drops. It was found that when attempting to hold an exact zero-gravity condition the engine oil pressure would drop to about 30 psi. This low pressure was found to be insufficient to control the speed of the propellers.

Another modification that was found necessary was the installation of specially designed battery caps to prevent the spillage of battery acid whenever a slight negative gravity condition was encountered.

It also was found that the addition of a specially modified sensitive gravity meter for the pilot to use in holding the required gravity readings for the various parts of the maneuver was extremely helpful and is now standard equipment on all flights. It is possible for the pilots to fly this instrument to within 0.05 g. This instrument is important for attaining and holding zero gravity and also for guidance so no more than $2^1/_2$ g's are pulled during the entry to the maneuver and during the recovery.

**A Method of Determining the Transient Temperature Distribution in an Entry-Vehicle Heat Sink.....59—Av-31**

By J. C. Tearnen, Assoc. Mem. ASME, Convair—Astronautics, San Diego, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

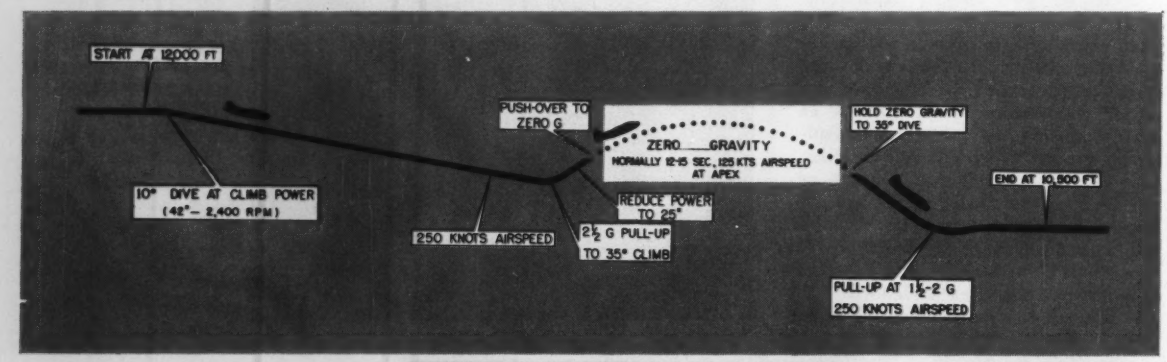
A rapid and convenient method is presented for determining the temperature distribution in a slab subjected to an arbitrarily varying heat-rate input. The application of this technique to the design of nonmelting heat-sink type entry protection systems is indicated. A method of including surface-radiation effects by use of successive approximations is also outlined.

The nonmelting, radiation-cooled heat-protection surface is of particular interest for satellite and interplanetary entry vehicles because of simplicity and due to the fact that such surfaces retain their aerodynamic shape during and after entry. Such vehicles can make use of skip-glide maneuvers to control heating during entry and can be flown to predetermined landing points after the entry phase.

**The Use of Aerodynamic Lift During Entry Into the Earth's Atmosphere.....59—Av-36**

By Lester Lees, F. W. Hartwig, and C. C. Cohen, Space Technology Laboratories, Inc., Los Angeles, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

By employing aerodynamic lift during entry into the Earth's atmosphere, the range of permissible entry angles for a prescribed peak deceleration is greatly increased, while the total heat energy transferred to the vehicle can be held to


START AT 12,000 FT
PUSH-OVER TO ZERO G
ZERO GRAVITY
NORMALLY 12-15 SEC., 125 KTS AIRSPEED AT APEX
HOLD ZERO GRAVITY TO 35° DIVE
END AT 10,500 FT
10° DIVE AT CLIMB POWER (42"— 2,400 RPM)
REDUCE POWER TO 25"
250 KNOTS AIRSPEED
2½ G PULL-UP TO 35° CLIMB
PULL-UP AT 1½-2 G 250 KNOTS AIRSPEED

**Zero-gravity experiment at Wright Air Development Center, Aero Medical Laboratory, uses modified Convair C-131B transport aircraft to determine effects of short periods of zero gravity on human performance and behavior (59—Av-10)**

**Free floating during a zero-gravity period is demonstrated by Lt. M. S. Gardner, WADC, Aero Medical Laboratory. Golf ball just above his head is on a rubber band, under slight tension. During zero gravity, when golf ball becomes weightless, the slight tension pulls it up and rubber band forms a straight line. (59—Av-10)**

about the same value as for a nonlifting vehicle. For entry from orbital velocity, analytical expressions are obtained for peak G in the simple, illustrative case of constant lift-drag ratio up to peak G. For example, this analysis shows that the entry angle at 400,000-ft altitude can be as great as 9.5 deg with lift-drag ratio of 2.0 and a peak deceleration of 10 g's, as compared with a maximum allowable entry angle of less than 3.0 deg for a nonlifting vehicle. (The reader is reminded that the entry angle definition must include the entry altitude taken as 400,000 ft in this report.) The analysis also shows that beyond peak G only modest lift-drag ratios are required to prevent the deceleration from exceeding the peak value, and the unnecessary skip phase is entirely eliminated.

By employing continuous lift programming or lift modulation, the maximum permissible entry angle is increased for a prescribed peak G, or, alternatively, peak G is reduced. For example, if peak G is held to 10 g's, an orbital vehicle can enter at an initial angle of 12.5 deg if the lift-drag ratio is initially equal to 2.0. Alternatively, for an entry angle of 9.5 deg peak deceleration is reduced to 6 g's.

The effect of aerodynamic lift on the trajectory is even more pronounced for a vehicle returning to Earth from outer space at the approach velocity of about 35,000 fps. By employing positive lift up to peak G, and negative lift beyond peak G, the vehicle is prevented from skipping out of the Earth's atmosphere for an entry angle as low as 5.5 deg. By using negative lift initially the minimum entry angle is reduced to about 4.5 deg. When the maximum deceleration is held to about 10 g's, the maximum allowable entry angle is 10.5 deg for a lift-drag ratio of 2.0. Thus the difficult guidance control problem is greatly alleviated, and the necessity for multiple-pass drag braking is eliminated.

### A Photographic Study of Boiling in the Absence of Gravity.59—Av-37

By R. Siegel, Assoc. Mem. ASME, and C. Usiskin, Lewis Research Center, NASA, Cleveland, Ohio. 1959 ASME Aviation Conference paper (multilithographed; to be published in Trans. ASME—*J. Heat Transfer;* available to Jan. 1, 1960).

A photographic study was made to determine the qualitative effect of zero gravity on the mechanism of boiling heat transfer. The experimental equipment included a container for boiling water and a high-speed motion-picture camera.

To eliminate the influence of gravity, these were mounted on a platform which was allowed to fall freely approximately 8 ft. During the free fall, photographs were taken of boiling from various surface configurations such as electrically heated horizontal and vertical ribbons.

The heat flux was varied to produce conditions from moderate nucleate boiling to burnout. The results indicate that gravity plays a considerable role in the boiling process, especially in connection with the motion of vapor within the liquid.

### Problems Associated With the Assembly of a Multiunit Satellite in Orbit.....59—Av-25

By W. H. Clohessy and R. S. Wiltshire, The Martin Company, Denver, Colo. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Feasibility of assembling space rockets in orbit and of doing so with equipment and techniques already available or scheduled for availability in the next few years is demonstrated. The operation discussed here could just as well be the basis of a refueling or resupply capability. An approximately circular orbit at 500 statute miles above the earth's surface and with an inclination angle of 30 deg to the equatorial plane has been chosen as a feasible working orbit. This orbit is well below the 683 miles above which the recently discovered high-intensity radiation belt becomes a serious problem.

We assume the payload requirement relative to the orbiting capability is such that more than one piece will be placed in orbit and joined there. The pieces are envisioned to be functional modular units and their number and type dependent upon the satellite mission.

The requirements for the ultimate orbit are next assumed to be met by the first piece. This piece will contain the satellite power supply and certain communications equipment for ground tracking and generating signals to be received by the succeeding piece during their orbit transfer and rendezvous.

The accuracy of the satellite orbit is discussed first and an arbitrary specification of the orbit plane, apogee and perogee vectors is made. In general, these can be no more accurate than the ground tracking system which measures them. In most cases, the orbit accuracy requirements on the first piece will be such that present radar tracking systems will be adequate. However, this is certainly not true for succeeding pieces which must be brought into exactly the same orbit and space position at some time.

The critical limiting factor is thus seen to be the ground tracking system which determines the orbit of the pieces to be joined. It appears possible only to get the two pieces in the same region and with about the same orbits. Therefore an instrumentation system for measuring relative position and velocity must be devised which will effect a successful mating of the two pieces. The paper, then, presents an approach to the solution of the foregoing problems.

### Low-Thrust Transfer Between Circular Orbits.....59—Av-2

By E. Levin, Assoc. Mem. ASME, The Rand Corporation, Santa Monica, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

After a brief discussion of the basic equations relating to low-thrust trajectories, a specific formulation of the problem is presented. Also, it is shown that coplanar transfer between circular orbits can be effected by a program of constant thrust acceleration and a simple steering program utilizing purely circumferential thrust followed by purely radial thrust.

A rapidly converging series expansion is obtained for the solution to the equations of motion, and all the details of the motion may be determined from this solution to any desired accuracy.

It is then shown that the orientation of the orbit plane may be changed by appropriate constant thrust normal to the instantaneous plane of motion. The execution time for a given change in orientation of the orbit plane may be estimated from the formulas given.

### Dynamic Problems Associated With Satellite Orbit Control...59—Av-4

By B. W. Augenstein, Lockheed Missile Systems Division, Palo Alto, Calif. 1959 ASME Aviation Conference paper (in type; to be published in Trans. ASME—*J. Engng. for Indus.;* available to Jan. 1, 1960).

Many future satellite applications will require provision for changing the orbital parameters of the satellite once it is in an initial orbit. Such changes of orbital parameters can range from simple "orbit trimming," to correct initial guidance or propulsive inaccuracies, to relatively large-scale changes in the orbit for maneuvering purposes.

The magnitudes of impulsive applications of force required to perturb the orbit by desired amounts is calculated for some typical cases, under the assumption of a central force field. From these results, the case of continuously applied forces may be derived.

The treatment is perfectly general and permits analysis of the effects of arbitrary variations of an arbitrary initial conical motion.

For a few typical cases, the corresponding requirements of propellant consumption of chemical rockets is shown.

**Problems Associated With the Testing of Ion Thrust Chambers..... .....59—Av-35**

By A. T. Forrester, Rocketdyne, A Division of North American Aviation, Inc., Canoga Park, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Primary requirements of an ion-motor test facility are a vacuum system capable of handling high material efflux at very low pressures and electrical equipment capable of supplying high voltages and currents. Ion-current measurements must be divorced from confusing effects of secondary photoelectric and high field emission processes.

Measurements must be made of neutral efflux in the exhaust and component erosion rates. The effectiveness of devices and methods for insuring electrical neutrality of the exhaust should be tested. Direct measurement of the trust produced by such a device is also desirable for correlation with voltage and current measurements.

**Noise Control Measures for Jet Transport Operation....59—Av-6**

By R. J. Koenig, Mem. ASME, Convair, A Division of General Dynamics Corporation, San Diego, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

In operating turbojet-powered aircraft, there is concern about noise in communities adjacent to airports. Noise levels in the airport terminal area and in the immediate vicinity of the aircraft where maintenance personnel are stationed during engine run-up are also a matter to be considered.

With any noise-control problem, the acoustic characteristic of the noise source, the noise path, and the receiver of the noise must be considered.

In this paper the characteristics and control of the noise at the source and the path distance the noise must travel to the receiver, and the people located in the area of interest are discussed. The relationship between the areas of concern and the noise source are studied first. Reduction of the noise at the source through use of jet-noise suppressors for the Convair 880 and through modification of the basic engine design for the Convair 600 is discussed. The effect of distance on noise reduction is examined. A summary is given of the combined effects of source and distance as related to noise levels in the areas of concern during operational use of turbojet-powered aircraft. Actual ground-noise fly-over measurements are not presented, since such information will not be available until mid-1959 for the 880 and approximately a year later for the 600.

**Noise Suppressors for Avon and Conway Engines.....59—Av-49**

By F. B. Greatrex, Rolls-Royce Ltd., Hucknall, England. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

The art of jet-engine noise suppression has reached a stage where noise suppressors are now in production. This paper describes some of the development work which has been required in order to achieve on the Avon engines in the Comet and on the Conway engines in the 707-421 a satisfactory degree of noise suppression for a reasonable performance penalty against a production date.

In the discussion, effects of nozzle shape, uniformly divided nozzles, performance penalties, and arrays of circular nozzles are noted. Flight test measurements yield data from spectrum analysis.

Noise attenuation, performance penalties, external drag, and weight of the Avon and Conway suppressors are considered.

**The Design Characteristics of Inflatable Aluminized-Plastic Spherical Earth Satellites With Respect to Ultraviolet, Visible, Infrared, and Radar Radiation.....59—Av-38**

By G. P. Wood and A. F. Carter, Langley Research Center, NASA, Langley Field, Va. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Among the satellite experiments of interest is one involving the use of a large, lightweight, inflatable, plastic spherical shell. It would be desirable for this satellite to be easily visible to the naked eye, to be a good reflector of radar signals, and to have a long lifetime in orbit. The satellite would then have a number of uses which need not be discussed herein.

In addition to meeting a maximum weight requirement and an approximate minimum size requirement, there were therefore four requirements involving electromagnetic radiation in the spectrum from the extreme ultraviolet to radar wave lengths, inclusive, that were desired to be met. These were:

1 That the satellite reflect sufficient visible radiation from the sun to be readily discernible by the naked eye when at an altitude of the order of 1000 miles.

2 That the satellite reflect radar waves as well as practicable.

3 That the plastic which formed the shell of the satellite be protected from deterioration by long-term exposure to the sun's ultraviolet radiation.

4 That the satellite assume, by virtue of its reflectivity to solar radiation and its emissivity in the infrared, an equilibrium temperature in sunlight that was not too high and in the earth's shadow that was not too low.

The purpose of this paper is to describe the methods used and the results obtained in so designing the vehicle that it would, as far as was practicable, meet the four requirements involving radiation.

**Economics of Satellite Supply Vehicles.....59—Av-33**

By Robert Cornog, Thompson Ramo-Wooldridge, Inc., Los Angeles, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

A manned satellite having a gross mass of 100,000 lb has been postulated. In this paper the economics of the vehicle necessary to supply the satellite station is discussed.

Attention is concentrated on methods of reducing the direct flying costs of a shuttle-vehicle supply system.

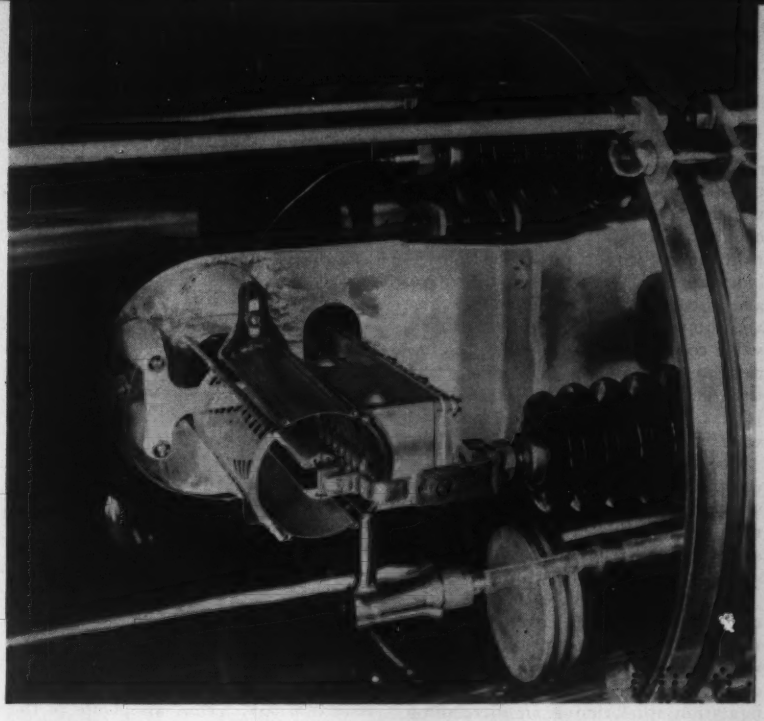
It is believed that, once development costs have been amortized, the direct flying costs will be the major component of the total cost of operating a supply system for satellite stations. Consequently, any method or approach which will materially reduce the direct operating cost of the supply system will also materially reduce the total costs of carrying material back and forth between a satellite space station and the earth surface.

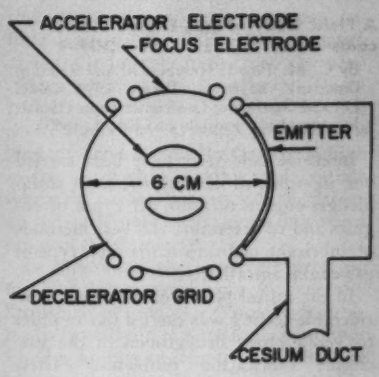
A number of factors must be considered in computing the direct flying cost of operating such a supply service. These factors have been divided into two sets.

One set of factors concerns the performance requirements which must be met by the supply service—items such as the size of payload and the frequency of service.

After these performance requirements have been specified, a second set of factors must be considered by a hypothetical contractor who is bidding to perform the required supply service. To be successful, the contractor must be able to compute the costs of providing the required service in the cheapest possible manner.

The problems and questions raised in both of these categories are much too broad to be covered comprehensively in a single paper. However, in order to help provide a plausible basis for the performance needs and the range of design constants covered in this paper, these input factors are discussed briefly.






**Cross section, *above*, of conceptual cesium-ion rocket designed for low current density (59—Av-32)**

**Cesium-ion rocket accelerator, *left*, in test chamber with x-ray shielding removed (59—Av-32)**

**Cesium-Ion Rocket Research Studies.....59—Av-32**

By R. N. Edwards and Guntis Kuskevics, General Electric Company, Evendale, Ohio. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Electrical propulsions systems will play an essential role in the development of space technology. They are reaction engines in which a source of electrical energy is used to impart kinetic energy to a suitable propellant. They will provide small thrust levels as compared to the mass of the vehicle, so they must be used with vehicles which have been boosted into a stable orbit by chemical or nuclear means. They may provide continuous thrust over very long periods so that the total impulse is very large in comparison with chemical systems of comparable weight.

A cesium-ion rocket is described which features a perfusing ion emitter and employs the accelerate-decelerate principle in a cylindrical geometry. The conceptual design of ion rocket is shown in cross section in the accompanying illustration.

Cesium vapor passes through a surface-ionizing emitter from the duct. Ions are accelerated through the slot in the accelerating electrode and then decelerated to the exit grid. They are mixed with electrons from the incandescent exit grid to form a neutral plasma which passes out of the rocket, providing propulsive thrust.

Efficiency studies of ion acceleration for design optimization are outlined, and curves which provide a valuable tool in the determination of the operating point for an efficient ion drive are presented.

Several barrier problems must be solved to prove engineering feasibility of the ion rocket. Feasibility of a propulsion unit requires that propellant be accelerated efficiently under control of the electrical system. The particular problems which might prevent achievement of this end include: ion generation, ion extraction, electrical breakdown, ion interception, sputtering erosion, and space charge neutralization. Supporting research in these areas is described.

**Positive-Displacement Hot Gas Motors for Auxiliary Power Units.....59—Av-43**

By W. Patterson, Vickers, Inc., Detroit, Mich. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

The hot gas motor auxiliary power unit (APU) is a compact, self-contained secondary power supply for aircraft and missile applications. Capable of providing 1 to 50 hp for limited periods, this unit consists essentially of an electrically ignited hot gas generator and a modified axial-piston hydraulic motor. To provide hydraulic power output, a positive-displacement pump can be integrated with the motor package. A regulator valve can be incorporated to maintain constant gas pressure, thereby providing constant hydraulic pressure.

The principal aircraft application of the hot gas APU is the starting of gas-turbine engines. Although the hot gas motor can be mounted directly to the engine starter pad, it is usually desirable to employ hydraulic transmission of the APU output. This would utilize an integral pump, driven by the hot gas motor, and a motor/pump unit attached to the engine starter pad. The motor/pump would be driven hydraulically by the APU to start the turbine engine. The engine would then drive the motor/pump mechanically, furnishing hydraulic pressure to the utility system. In multi-engine aircraft, only one engine is normally started by the APU; power from the first engine started is used to start the remaining engines. For repetitive APU starts, several gas generators can be provided, to be ignited individually as required. In addition to providing starting power, the hot gas APU can be used to drive an emergency generator.

As a missile component, the hot gas APU will furnish hydraulic power for flight controls and generator drives. An electric generator, together with a hydraulic drive motor, can be integrated with the APU package. In this case, a constant-speed motor can be used as a generator drive to provide voltage and frequency regulation.

For applications requiring short-duration peak demands, a hydraulic accumulator can be included in the APU package to supply the power peaks, while enabling a reduction in component sizes and propellant weight.

Inherent low speed and off-design-point efficiency are considered as advantages over turbine drives. Work is reviewed to substantiate feasibility and define operating range in terms of horsepower and running time.

## Oil and Gas Power

**A Field Study of Gas-Engine Lubricants—II.....59—OGP-9**

By C. M. Floyd, Humble Oil and Refining Company, Baytown, Texas. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

Intensive field tests have been carried out in order to develop the most suitable gas-engine oils for all types of engines and to determine the best methods of lubricant utilization for each type of gas-engine installation.

In the initial phases of the work, considerable testing was carried out in order to get a broad background of the gas-engine lubrication problems. These problems are discussed briefly.

The adequate testing of gas-engine lubricants, of necessity, requires a long and careful study of a large number of engines operating under known field conditions. Therefore, in all field test work a minimum of 8000 hr (one year) per engine is required and multiple installations are required to permit allowances for individual engine differences.

It soon became apparent that the requirements for the 2-cycle engines were not necessarily the same as those for the 4-cycle engines so that it was desirable to treat the two types of engines separately in the study. It was also soon apparent that different models of the various engine makes had somewhat different requirements for the oils. This, in turn, required the testing of different makes, models, and types of engines.

One of the primary purposes of the test work was to develop an all-purpose line of gas-engine lubricants. This required that the various oils and additives combinations be tested in a large number of engines. Since the author's company has some 150,000 gas-engine horsepower representing some 300 machines of over 21 makes and models available for study in the Gulf Coast area, a wide choice of engines was available. Also, some data were available from engines not on formal tests which, in turn, helped to define some of the problems. Further information on gas-engine problems was received from the various engine builders, from discussions with lubrication engineers, and from customer engines.

**Development and Application of a Small, Four-Cycle, Turbocharged Gas-Compressor Engine.....59—OGP-1**

By W. M. Kauffmann, Assoc. Mem. ASME, and D. E. Schultz, Worthington Corporation, Buffalo, N. Y. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

During 1953, a comprehensive survey resulted in authorization to proceed with the design of a four-cycle gas engine, utilizing turbocharging and air aftercooling. Specifications were for a nominal rating of 95 bhp per cylinder at 134 bmep with $11^1/_2$-in. bore, 12-in. stroke, and piston speed of 900 fpm for engine and compressor at 450 rpm. Overhead-valve construction with pushrod actuation of the valve gear, enbloc frame with individual integrally cast liner and jackets, and four bolt head fastening were incorporated.

The prototype experimental unit was equipped with an adjustable camshaft which permitted altering the relative timing of inlet and exhaust cams, as well as means for removing cams without disturbing the shaft.

The program for evaluating the turbocharging application covered a broad scope of investigation, among these were effect of valve overlap, turbine-nozzle ring area, blower-diffuser configuration, spark timing, air aftercooling, and the related changes and modifications to the basic design. Concurrent with these studies, the development of a gas-air-ratio control system, which would fulfill requirements of the variable load and speed range was expedited.

A complete appraisal of turbocharging theory was initiated and results evaluated in the engine by temperature probes and M.I.T. diagrams simultaneously recording cylinder, exhaust, and inlet-air manifold pressure variations.

The theory, design, research, and application described in this paper outline some problems in the development of a small four-cycle, turbocharged, spark-ignition gas engine That this has provided a unit of high thermal efficiency, is evidenced by performance data. Further work will undoubtedly extend the scope and acceptance of this new type of engine.

**Lubrication! Sez Who?.....59—OGP-4**

By R. L. Churchwell and F. J. Kokas, Tennessee Gas Transmission Company, Houston, Texas. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

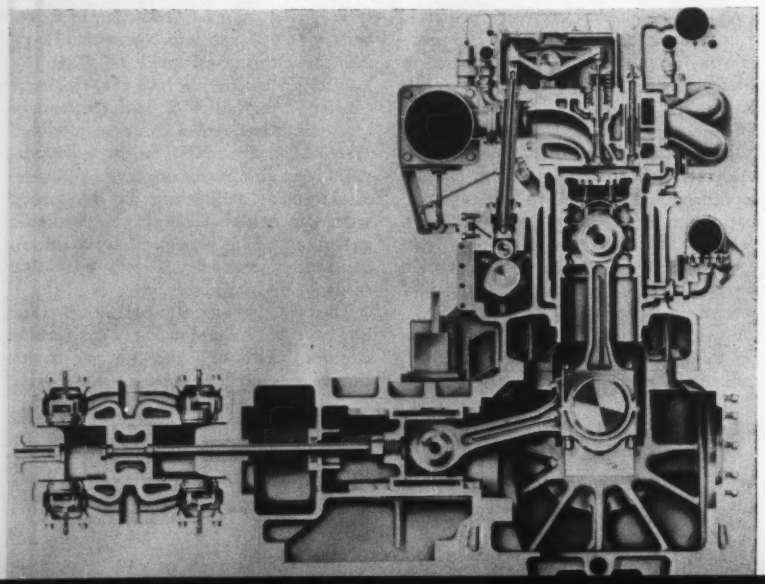
Management's concern over the wide variation in oil consumption on similar engines in similar locations, resulted in the initiation of a study by the Research Department of Tennessee Gas Transmission Company. Field attack was not considered feasible until the component parts of the lubricating system had been tested. Consequently, lubricator reservoirs complete with pumps were transferred from field service to the laboratory for testing in order that field equipment and conditions could be more nearly simulated.

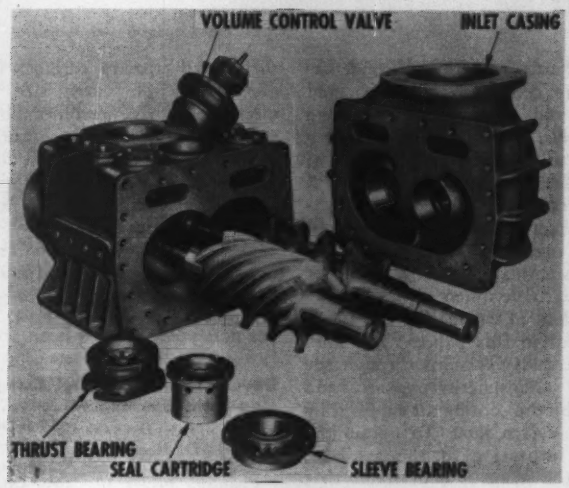
Lubricator pumps were mounted in standard reservoirs with a common drive shaft, which was train driven with a constant-speed motor through a gear-reduction box. Thus all pumps of the test apparatus were known to be operating at the same known rpm.

After all lubricators under test had been set to the same apparent delivery rate, the driving motor was then started and the output of each pump was collected in a weighed glass bottle. A substantial amount of oil sample was collected, and the bottles were again weighed. The gravity of the oil was determined at the operating temperature, and calculations were made to convert from the weight delivered to quarts per day.

Laboratory tests revealed that the "drop counting" and "turns" methods of adjusting force-feed lubricators are inaccurate, and that the vacuum-type pumps present operating difficulties. Many of the lubrication problems of gas engines may be attributed to this inconsistency of lubrication rates.

**Basic cross-sectional design of small, four-cycle, turbocharged gas-compressor engine (59—OGP-1)**






**Exploded view model of 105L4 (10.5-in.) standard line compressor with volume control (59—OGP-3)**

Also investigated were the effects of high oil temperature, pressure delivered against, and O-ring correction of slippage. A stroke-measuring method has been devised which permits a more accurate control, and which helps to develop lubrication consciousness. The field modification program far exceeded expectations in substantial lubrication and maintenance economies.

**Advantages of Tailor-Made Construction Contracts.....59—OGP-6**

By R. F. Smail, Dravo Corporation, Pittsburgh, Pa. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

One of the first and most important ingredients of any construction contract, regardless of form or type, is confidence of the customer in the contractor. No one can do his best work unless he feels that he has the complete understanding of those with whom he is working.

A successful construction project is a partnership of contractor and customer, each co-ordinating his efforts with the other in the prosecution of the work. This does not mean that each party should be free to do what he pleases. The contractor should encourage the right of the customer to inspect the work, seeing that it fulfills the specifications. However, the contractor is entitled also to fair treatment from the customer. In most phases of life we are able to form or shape plans to meet the exact requirements of unusual situations. This holds true for the preparation of construction contracts as well.

This paper outlines some of the special circumstances that are involved in the many types of construction projects, and the different types of contracts that may be tailored to fit each situation.

**Production Design of a Modern, Axial-Flow Positive-Displacement Rotary Compressor....59—OGP-3**

By W. C. Fischer, Mem. ASME, Fairbanks, Morse and Company, Beloit, Wis. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

In the continuous effort to improve the efficiency of its 2-cycle diesel engines, the author's company has investigated numerous scavenging-air blowers and compressors. The efficiency of this engine component obviously affects engine fuel consumption considerably.

As part of a search for more efficient scavenging means, the axial-flow positive-displacement compressor was investigated. It showed such promising characteristics and design features that it was decided to undertake the development of a complete compressor line. It will no doubt be applied to diesel engines as dictated by requirements, and where it can be incorporated in new design or redesign of engines. It may, later on, find application as a turbocharger.

The results of extensive research and development work on this compressor are reviewed. The paper also shows how a practical system for design calculations was developed. There follows a discussion of the various design considerations applied to the layout of a consistent line of compressors recently placed in commercial production. A summary of field applications is included.

**Mechanical Isolation of Torsional Vibrations.....59—OGP-8**

By G. A. Dorton, The Cooper-Bessemer Corporation, Mount Vernon, Ohio. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

The elimination and/or minimizing of the effects of torsional vibrations has long been a difficult problem in multicylinder, relatively high-speed engines.

This problem and its solution are especially acute when an engine-driven shaft, subject to torsional vibrations, is used to drive a member having a high inertia or with a flexible-shaft system where the natural frequency of the driven masses falls within the operating speed range of the engine.

In these cases the required protection for the driven machinery is generally furnished by some torsionally flexible media, usually in the form of a coupling. Fluid couplings of the slip type offer the ultimate in vibration isolation but they are limited in their use because of their size and cost. Thus in the majority of cases the vibration analyst has turned to the use of resilient couplings to help him out of torsional-vibration problems.

Conventional resilient couplings are constructed using metallic or rubber springs. These devices are characterized by the disadvantage that the elastic materials used are subjected to fatigue and hence early failure. The centrifugal coupling described in this paper eliminates the need for elastic material and substitutes the effect of centrifugal force as its flexible medium.

The coupling consists of a driving flange attached to a shaft or engaged by some means of transmitting torque; a driven flange which may be attached to a shaft; and a plurality of rigid links which are assembled in pairs in a manner that enables pivoting at the link junction. The jointed pairs of links are connected to the driver and driven members in a manner that will allow free pivoting when the drive flanges move relative to each other. The only operating requirement is that the driving link leads the driven link, thus the load is transmitted in the links.

**Evaluation of Corrosion in Diesel Cylinders.....59—OGP-2**

By J. M. A. Van der Horst, Mem. ASME, Van der Horst Corporation of America, Olean, N. Y.; and W. Schultze, Lemet Chromium, N. V., Kortenhoef, Netherlands. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

It is often important to be able to distinguish whether cylinder wear is caused by corrosion or by abrasion, especially if one wishes to test wear-reducing agents. None of the existing methods of wear measurement or evaluation makes an adequate distinction between corrosion and abrasion.

A procedure has therefore been devel-

oped which offers a rapid evaluation of the effects of corrosion only, excluding virtually any influence of abrasion. This procedure also demonstrates which area of the cylinder bore is particularly exposed to corrosion.

Data gathered from three engine tests, concerning the mechanism of cylinder-wall corrosion and the variables involved, are reviewed and submitted to statistical analysis.

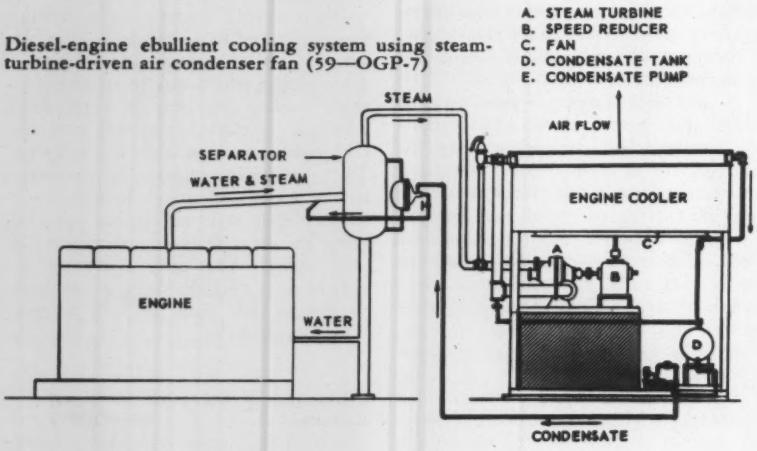
Corrosion characteristics of fuel-lubricant-temperature combinations can be evaluated by 40-hr test runs.

Engines used for this purpose may need some running time to stabilize themselves, after having been idle or operated under an entirely different regime.

Mere emulsification of a straight-run lubricating oil with water 2:1 and 2 per cent G 2855 may offer some advantages in heavy fuel operation.

The special marine lubricants (HD) tested, such as are marketed by the major oil companies for use with heavy fuel, some high additive mixtures compounded for this test, including higher levels of the emulsifiers G 2855 and Fixanol C without water, as well as an emulsion containing ammonia gave very high corrosion protection.

**Diesel-engine ebullient cooling system using steam-turbine-driven air condenser fan (59—OGP-7)**




### Engine-Waste Heat Utilization in a High-Speed, Geared Steam Turbine .....59—OGP-7

By J. C. Georgian, Mem. ASME, Washington University, St. Louis, Mo. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

Diesel-engine cooling by means of boiling heat-transfer or ebullient cooling has received considerable attention within the past few years because of its numerous advantages. These advantages include more uniform heating of cylinder walls and heads, reduction of condensation in the combustion chamber and crankcase, and the possibility of using cheaper fuels. The ebullient cooling system has many of the characteristics of a low-pressure watertube boiler. A steam separator is required that separates the steam from the boiling water. The system operates at about 15 psig, and the steam is normally sent to a condenser and returned to the system.

One method of condensing the steam is considered in this paper. The low-pressure steam is expanded through the turbine to atmospheric pressure, and condensed by the cooling air supplied by the turbine-driven fan. To obtain the maximum utilization of the available energy in the steam it is desirable that the turbine have the highest possible efficiency.

This utilization of waste-heat energy for jacket cooling has become fairly common over the past decade, particularly with small engines in sewage plants and in the petroleum industry. The jacket heat rejection on these engines was normally ample for the heat requirement of the fan turbine.

With the development of the supercharged diesel engine, and especially the supercharged gas engine for pipeline work, engines have become so efficient that the heat available for generating steam has been considerably reduced. Therefore in order to obtain enough power to condense the steam and supply cooling air for lube oil, gas, and so on, it becomes necessary for the turbine to have higher efficiency.

At the present time there is not available a mechanical drive turbine of high efficiency in the very small ranges of say a few to 50 hp. It is possible to purchase such small-capacity turbines but these are usually the large size, ordinary mechanical drive turbines nozzled for very small flows. These turbines are inefficient (*a*) because of the low arc of admission and, (*b*) the wheel speed is not at the optimum value to extract the energy in the steam efficiently.

Design, development, and test results of a small high-speed geared steam turbine suitable for driving fans or generators are described in this paper.

### Development of a High-Compression-Ratio Gas Engine.....59—OGP-5

By R. D. Henderson and J. C. Hallinan, Assoc. Mem. ASME, Caterpillar Tractor Company, Peoria, Ill. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

Availability of improved ignition systems and the expanding use of natural gas as an engine fuel make the high-compression, spark-ignition engine an economically attractive power plant for many areas of the world. Laboratory development and field tests have been reviewed.

The objective of producing a gas engine to equal or exceed the output of the naturally aspirated diesel engine has been attained. Six, eight, and twelve-cylinder $5^3/_4$-in-bore engines are being marketed. Based on field experience, the rugged construction of the engine has provided the expected long service life for basic engine components. The ignition and carburetor systems purchased from our suppliers are providing excellent service. We have outlined some possible future steps which can be taken to provide the customer more power and economy without altering the basic engine design.

### Installation, Operation, and Maintenance of Turbocharged Gas-Engine Compressors..59—OGP-10

By W. H. Payne, Mem. ASME, and G. H. Bollman, Clark Brothers Company, A Division of Dresser Operations, Inc., Olean, N. Y. 1959 ASME Oil and Gas Power Conference paper (multilithographed; available to Feb. 1, 1960).

Horsepower output of a naturally aspirated or mechanically scavenged engine is limited by the amount of air that can be drawn into its power cylinders at or against atmospheric pressure. As higher and higher power ratings are required, greater numbers of engines or larger sized engines had to be considered. Simultaneously manufacturing and plant-construction costs increased rapidly.

Turbocharging or supercharging air

into the power cyclinders with a blower and against the back pressure of the exhaust gas turbine appears to be an area of economy.

The turbocharged engine does not have any limitation on the volume of air. A turbocharger that is not hampered by a constant-speed mechanical blower produces a flexible supply of combustion air, a supply in proportion to the energy in the exhaust gas.

Exhaust energy is proportional to engine load, therefore the combustion air supply is also proportional to engine load. This means that at reduced engine output, the combustion air supply is also low but increases to a maximum at maximum load. The designer is no longer tied to the requirement of best economy fuel/air mixture at rated power since the fuel/air mixture remains near best economy over a wide range of loads and the operator can always be assured of an instantly available supply of combustion air when he needs it.

In addition to supplying maximum combustion air for maximum load, the turbocharger also supplies near optimum combustion air for a wide range of other conditions. Operators of mechanically scavenged engines have had to resort to complicated unloading practices in order to control compressor capacity because of relative inflexibility of the air supply of the engine. The turbocharged-engine operator, of course, needs only unload to prevent excessive torque. Capacity control can be largely handled by varying the engine speed to produce the desired capacity with practically no sacrifice in fuel economy.

Operating economies of the turbocharged gas-engine compressor are mentioned. The tremendous increase in demand for this type equipment is explained. Possibilities for automation are noted as are maintenance and cleaning methods.

## Power Generation—American Power Conference

### An Operating Report of the Monitored Sterlington Station.....59—APwr-2

By Donald Aswell, Louisiana Power and Light Company, New Orleans, La.; and George Parmakian, Mem. ASME, Riley Stoker Corporation, Worcester, Mass. 1959 American Power Conference paper (multilithographed; available to Jan. 1, 1960).

In June, 1958, the Louisiana Power & Light Company placed into operation a 210-megawatt unit at its Sterlington Steam Electric Station, representing an advanced step toward the ultimate automated power plant. Working closely with their design engineers, Ebasco Services Inc., of New York, N. Y., the power company has installed considerable equipment that will undergo operating tests for reliability to determine whether it will be used in future plants that will be automatically operated in all phases.

At the Sterlington plant, equipment has been installed that should be capable of meeting part of the requirements of power-plant automation. This is the general-purpose solid-state computer with a solid-state analog-to-digital converter. As installed, the computer is doing only a portion of the functions that ultimately will be required for automation, but it should provide operating experience and confidence in part of the hardware that will be used.

The equipment scans 200 temperatures for abnormal conditions at a rate of 5 points per sec and logs 100 other plant variables periodically, or on demand, for plant results or accounting purposes. Any scanned point will be printed in digital form and identified, if above or below a set value. The logged items are the usual points the operator records. All conventional multipoint recorders, temperature scanners, historical recorders, and log sheets are replaced by this equipment.

During the scanning cycle each of the 200 temperatures is checked once every 2 min. Should an off-normal temperature be detected, the value, time, and point identification number will be printed on a high-speed printer and an audible annunciator will sound an alarm and flash a light identifying the equipment in trouble. It is then up to the operator to make a decision for corrective action. Each succeeding scan cycle will continue to print the point values as long as it remains off normal. This gives the operator information for applying corrective action or shutting down the equipment in trouble.

The automatic data-collection (ADC) system has notified the operator on several occasions when there were off-normal temperatures in the plant, among them:

1 High temperatures on the boiler-feed-pump motor bearings due to plugging of the oil cooler.

2 High superheater-tube metal temperature caused by adjustments made on the burner air directional vanes.

3 High seal-water temperature on instrument air compressor and vacuum pump that developed when cooling water was shut off.

### Large Steam Turbine-Generators for the 1960's.....59—APwr-3

By E. H. Miller, Mem. ASME, and B. M. Cain, Mem. ASME, General Electric Company, Schenectady, N. Y. 1959 American Power Conference paper (multilithographed; available to Jan. 1, 1960).

Considering the over-all aspects of power generation, ten years is a long time in the fast-growing electric utility industry. It is not possible to predict, that far in advance, specific pioneering steam turbine-generator designs or steam conditions. In reviewing past advances in steam conditions and in power plant equipment, we can see that a number of years of proved satisfactory service in pioneering stations generally is required before major advances are widely accepted by the rest of the industry.

Therefore a large portion of the turbine-generator progress of the 1960's will be simplifications, improvements, and extensions of present designs as the power generation industry consolidates the gains now being proved out in pioneering power plants. Within this framework, tandem-compound, steam turbine-generators will be extended to 400,000 kw, and perhaps to 500,000 kw during this period. Cross-compound units may approach 1,000,000 kw.

Even now, 3500-psi initial pressure can be applied to almost all our large steam turbine-designs, but will continue to be most favorable at the larger ratings. Conductor-cooled generators with liquid-cooled stators and gap-pickup hydrogen-cooled rotors, already familiar to the utility industry, are expected to become the standard design as the average unit rating increases.

### Ultrasonic Testing of Large Steam Turbine Parts.....59—APwr-1

By L. E. Smith, Tennessee Valley Authority, Chattanooga, Tenn. 1959 American Power Conference paper (multilithographed; available to Jan. 1, 1960).

The ultrasonic method of internal-flaw detection utilizes a principle similar to that of radar. If a pulse of energy is sent into a transmission medium, it will be propagated without reflection until a change in the transmission medium is reached; then a portion of the energy

is reflected. If the velocity of the energy pulse is known, the distance to the reflection can be determined in terms of the time required for the pulse to travel to and from the reflector. The frequency of each individual wave of the initial pulse of energy may cover a very wide band and still produce a reflection, or what is commonly known as an echo.

Principles of the general methods used in ultrasonic testing, together with the advantages and limitations of available equipment for field testing by an electric utility, are presented in this paper.

Some specific applications that have had practical field use, such as in the testing of generator parts, consisting of building bolts and retainer end rings, are also shown.

Ultrasonic testing of thrust bearings is described and testing of auxiliary equipment is mentioned.

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A NUMBER of papers and reports, not preprinted or published, were presented at ASME Meetings. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 50 cents per page. Microfilm copies are available at a cost of $2 for 40 pages or fraction thereof.

The following papers recently have been placed on file in the Engineering Societies Library:

### 1958 ASME-AIME Joint Solid Fuels Conference

Drying of Fine Coal, by C. W. Gordon

### 1958 ASME Petroleum Mechanical Engineering Conference

Welding Neck Tapered Face Flanges for Use With Cast Iron Flanged Components, by H. H. George and E. C. Rodabaugh

### 1958 ASME Annual Meeting

Scale Model Tests for Evaluating Outer Containment Structures, by W. E. Baker

Design Requirements for a Stamping Press for Producing Quality Parts Safely, by W. D. Berry

New Developments in Reinforcements, by W. E. Dirkes

Some High-Speed Tensile Properties for Thermoplastics, by R. E. Ely

Selective Surfaces and Solar Absorbers, by E. A. Farber

Use of Radioactive Tracers for Evaluation of Wear in Locomotive Diesel Engines, by P. V. Garin and P. L. Pinotti

Influence of Size on the Rate of Gravity Flow of Spherical Particles, by R. M. LaForge and S. T. Hatcher

Equipment Available for Flame Failure Protection of Large Oil-Gas-Coal Fired Boilers, by G. E. Lind

The Effect of Ultrasonic Energy Upon Evaporation of Fuel Drops, by W. Mirsky and J. A. Bolt

Design Considerations in a Reinforced Plastic Spherical Pressure Vessel, by H. R. Nara

How Design Carry-Over and Basic Technical Evaluation Designed the DC-8 Air Conditioning, Pressurization, and Ice Protection Systems, by W. W. Reaser

Prediction of Load and Creep-Deflection in Beams and Eccentrically-Loaded Members, by G. M. Sidebottom and S. Dharmarajan

### 1959 ASME Aviation Conference Paper

Development and Testing of U. S. Army Earth Satellites, by J. A. Chambers

Orbital Simulations, by A. Fine

High Altitude Testing of Propulsion Systems, by B. H. Goethert and D. Taylor

Aircraft Air Conditioning Development Using A Thermal Mockup, by P. F. Halfpenny and P. S. Starrett

The Handling and Transportation of Nuclear Fuels, by D. L. Hillis

Power Requirements and Electrical Systems for Space Vehicles, by N. S. Pixley and R. S. Miller

Role of Ground Support in Manned Space Systems, by B. F. Werner

The Development of an Electric-Arc Gun and Model Telemetry for Use in a Hypervelocity Range, by A. J. Zazzi

### 1959 ASME Textile Engineering Conference

Trends in Finishing Plant Ventilation, by H. W. Frederick

### 1959 ASME Instruments and Regulators Conference

Novel Controls Using a Dead-Time Analog, by O. J. M. Smith

### 1959 Joint ASME-AIEE Railroad Conference

Corrosion Effects on Railway Equipment, by E. A. Foster

Machinery for Mechanized Railway Maintenance, by G. M. Magee

### 1959 ASME Oil and Gas Power Conference

Nondestructive Tests and Inspections in Pipeline Operations, by C. F. Dye

## Gas Turbine Power

**Presentation of a Blade-Design Method for Axial-Flow Turbines, Including Design and Test Results of a Typical Axial-Flow Stage.....59—GTP-4**

By F. Baumgartner and R. Amsler, Assoc. Mem. ASME, Boeing Airplane Company, Seattle, Wash. 1959 ASME Gas Turbine Power Conference paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Jan. 1, 1960).

A method is presented to determine the shape of stationary nozzle blades and rotor blades for an axial-flow-type turbine in a generally consistent manner based on the concept of aerodynamic blade loading. The mean blade load is a typical design parameter which predominantly determines the blade curvature. It depends in particular on the rate of charge of momentum across the blade row. By applying the design method, airfoil shapes are obtained which satisfy the momentum requirements regardless of what blade-load distribution is assumed as long as the mean blade load remains constant. A specific application of the design method is described and test data are presented which show that good agreement between design goal and test results was achieved.

**The Transient Response of Gas-Turbine-Plant Heat Exchangers—Regenerators, Intercoolers, Precoolers, and Ducting....59—GTP-5**

By A. L. London, Mem. ASME, and J. W. Mitchell, Stanford University, Stanford, Calif.; and F. R. Biancardi, United Aircraft Corporation, East Hartford, Conn. 1959 ASME Gas Turbine Power Conference paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Jan. 1, 1960).

This paper is the second report on a program dealing with the transient response of heat exchangers. For the report on the first part of the program, see Trans. ASME, vol. 80, 1958, p. 1169.

There are few solutions in the literature for the transient response of heat exchanges applicable to gas-turbine plants. It is the purpose of this report to summarize these in graphical form and supplement them with additional results obtained analytically and by an electromechanical analog. These results are reported graphically, employing a suitable set of nondimensional parameters, in a form immediately useful to the designer for, at least, preliminary estimating purposes. The lag in the temperature response of a fluid as a result of duct-wall capacity is also of interest;

ASME TRANSACTIONS

The May, 1959, issues of the Transactions of the ASME—*Journal of Heat Transfer and Journal of Engineering for Industry* (available at $1.50 per copy to ASME Members; $3 to nonmembers) —contain the following:

## Journal of HEAT TRANSFER

Vol. 81 • Series C • No. 2


95 Heat and Mass Transfer From a Rotating Disk, by F. Kreith, J. H. Taylor, and J. P. Chong.

106 Numerical and Machine Solutions of Transient Heat-Conduction Problems Involving Melting or Freezing, Part I, by W. D. Murray and Fred Landis. (58—HT-16)

113 A Theory of Rotating Condensation, by E. M. Sparrow and J. L. Gregg. (58—A-70)

121 Laminar Heat Transfer in Rectangular Channels, by L. S. Han. (58—A-124)

129 Heat Transfer to Water in Thin Rectangular Channels, by S. Levy, R. A. Fuller, and R. O. Niemi. (58—A-127)

144 Combined Geometric and Network Analog Computer for Transient Heat Flow, by Victor Paschkis. (58—A-69)

151 Heat Transfer From an Annular Fin of Constant Thickness, by H. H. Keller and E. V. Somers. (58—A-116)

157 A Variational Method for Fully Developed Laminar Heat Transfer in Ducts, by E. M. Sparrow and R. Siegel. (58—A-92)

168 The Effect of Surface Roughness on the Convection Heat-Transfer Coefficient for Fully Developed Turbulent Flow in Ducts With Uniform Heat Flux, by R. T. Lancet. (58—A-122)


## Journal of ENGINEERING FOR INDUSTRY

Volume 81 • Series B • Number 2


95 The Strength of Thick-Walled Cylinders, by B. Crossland, S. M. Jorgensen, and J. A. Bones. (58—Pet-20)

115 Steady-State Creep Analysis of the Weight Loadings of Furnace Tubes on Multiple Supports, by J. L. Jacobwitz and C. K. Mader. (58—Pet-14)

126 How to Replace Gears by Mechanisms (Linkages), by Kurt Hain and Gerhard Marx. (58—SA-33)

131 The Effect of a Lead Additive on the Machinability of Alloy Steels, by Norman Zlatin and J. V. Gould. (58—SA-53)

139 Controlled Contact Cutting Tools, by B. T. Chao and K. J. Trigger. (58—SA-42)

152 A Study of the Effects of Tool Flank Wear on Tool Chip Interface Temperature, by D. R. Olberts. (58—SA-41)

159 Synthesis of Path-Generating Mechanisms by Means of a Programmed Digital Computer, by Ferdinand Freudenstein and G. N. Sandor. (58—A-85)

169 Synthesis of the Four-Bar Linkage to Match Prescribed Velocity Ratios, by Philip Barkan and E. J. Tuohy. (58—A-115)

178 High-Range Plasticity of Metals Beyond Normal Work-Hardening, by E. V. Crane and W. S. Wagner. (58—A-132)

183 Self-Excited Vibrations in Metal Cutting, by N. H. Cook. (58—A-189)


consequently, this "single-fluid" heat exchanger is treated along with the "two-fluid" regenerator, intercooler, and precooler problems.

While these results are also applicable to the heat exchangers found in steam power plants and the process industries, primary emphasis is given in this report to gas-turbine-plant exchangers. Two gains are achieved by this limitation; namely, (*a*) by having a specific application in mind the physical significance of the nondimensional parameters is more apparent; and (*b*) a convenient limitation on the number and range of the parameters is gained.


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# COMMENTS ON PAPERS

## Performance Tests of a Vertical Steam Generator for Nuclear Power Plants

**Comment by G. M. Bonnett[1]**

THE authors of this paper[2] have indicated that the feedwater heater used to supply the heat which is removed by the steam generator has adequate capacity to establish any of the desired primary-coolant transients. However, the report is notably lacking in data or indication that the test covered transients of the primary coolant. It appears that this might be a valuable adjunct if not truly a necessity for complete evaluation of the unit.

The absence of a feedwater heater in the secondary loop is also noted which can only lead to the assumption that relatively cold feed was used for all tests. This is recognized to be a more stringent test than actuality but prevents the study of a variable feedwater temperature which could affect water level considerably. This might negate the conclusion that water-level control is not critical. Swell suppression by feedwater would also appear to be less at higher feedwater temperatures.

The authors have an interesting hypothesis in their discussion of increasing moisture content of the steam on a load decrease. A discussion or investigation of the time delays existent in the calorimeter technique for determining quality might prove fruitful here.

An operating characteristic of the control equipment seems to be that the water level is programmed versus the steam load or this is simulated by chosen starting points for tests. All of the increasing load transient curves exhibit this. It appears that water levels in excess of +12 in. might occur if this were not so. It is, therefore, necessary that this be mentioned in the report.

[1] Senior design supervisor, Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

[2] R. L. Coit and C. C. Peake, "Performance Tests of a Vertical Steam Generator for Nuclear Power Plants," MECHANICAL ENGINEERING, vol. 80, December, 1958, pp. 56–60.

### Authors' Closure

The following is offered in response to Mr. Bonnett's comment:

Primary coolant transients resulting from variation in steam load are shown in Figs. 7–11. Additional primary coolant transient tests such as primary coolant pump failure, emergency cooling, and so on, were also conducted with no adverse effects in the steam generator.

The feedwater supplied to the steam generator was normally in the range of 75–85 F. During one series of tests the temperature of the feedwater was increased (by bleeding air into the condenser to 150 deg). No difference in transient performance, swell, or shrink was detected.

It is appreciated that the feedwater temperature would be of the order of 350 deg during operation, but the facility limited the feedwater temperature to approximately 150 F. Subsequent field tests have shown that at 300–350 F feedwater temperature, the transient response is essentially the same as with 85 F feedwater.

The steady state water level was programmed to establish −10 in. water level at 15 per cent steam flow and +3 in. water level at 100 per cent steam flow.

R. L. Coit.[3]
C. C. Peake.[4]

[3] Manager, Development and Application Section, Heat Transfer Engineering, Westinghouse Electric Corp., Lester, Pa. Mem. ASME.

[4] Development and Application Section, Heat Transfer Engineering, Westinghouse Electric Corp., Lester, Pa.

## Air Conditioning for an EDPM Room

**Comment by F. H. Touchton[5]**

I AM happy to have the opportunity to discuss this paper.[6]

Clients rarely recognize the problem that adequate space for equipment should be provided—they count equipment area as lost space for their office functions. When air-conditioning equipment is installed without adequate room for easy maintenance, the equipment generally suffers therefrom and has a shorter life due to lack of proper maintenance.

I believe an investigation might have been made on the project discussed by the author to obtain draftless diffusion of the air throughout the room by using perforated metal ceilings. The amount of air to be introduced through such a ceiling, of course, would only be that necessary to maintain room conditions exclusive of equipment requirements. The author states that the room has an area of 2300 sq ft and if an assumption is made that approximately 2000 sq ft of ceiling area is available for air diffusion and 13,700 cfm is used to maintain room conditions, then there would be a 2.8 ft per sec air velocity downward through the perforated ceiling. This should give adequate draftless air distribution. There is at least one hospital in the Baltimore, Md., area which has a ceiling of this type that is operating satisfactorily. When the ceiling space is used for distribution of air in this manner a return duct system is required.

This article is devoted to the method of supplying a sufficient quantity and quality of air to satisfy both room and equipment requirements. EDPM equipment over the years has grown steadily more complex and larger in size. As the equipment grows larger, greater

[5] Project engineer, Mechanical Division, Whitman, Requardt and Associates, Baltimore, Md. Mem. ASME.

[6] J. R. Bailey, "Air Conditioning for an EDPM Room," MECHANICAL ENGINEERING, vol. 81, January, 1959, pp. 43–45.

quantities of heat are generated thus increasing the duty required of the air-conditioning equipment and there is no reason to suspect that this trend will not continue for some time to come. I understand that such equipment in the future may have the vacuum tubes replaced by transistors which should considerably help the heat situation.

However, it seems to me that the manufacturer of equipment should incorporate self-contained means for cooling the equipment. This could be accomplished by a completely self-contained air-conditioning unit or at the least the provision of a cooling coil and fan so that the owner would be required only to furnish chilled water to the coil.

Also as the equipment becomes larger and the heat produced therefrom becomes greater, it is obviously impossible to provide the quantity and quality of air required through a general space conditioning system.

### Author's Closure

Mr. Touchton's comments on the use of perforated ceiling panels for air conditioning of an EDPM room are based on the assumption that the load is uniformly distributed over the entire room. This, however, is not the case. My experience with EDPM rooms has been that they have highly concentrated loads in some areas and relatively light loads in other areas. I have investigated the use of perforated ceiling panels but have not been able to find any that can handle the large volumes of air required in the areas of high heat concentration.

I agree that the problem of air conditioning an EDPM room would be greatly simplified by the use of self-contained means for cooling the equipment; however, I do not believe that anything will be done in this respect unless the air-conditioning problems become impossible to solve by the use of conventional air-conditioning systems.

**J. R. Bailey.**[7]

[7] Assistant project engineer, Whitman, Requardt and Associates, Baltimore, Md. Mem. ASME.

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# REVIEWS OF BOOKS

## Aerodynamic Characteristics of Turbine Blading

**Calculation of the Aerodynamic Characteristics of Turbine Blading**

By N. M. Markov. Translated from the Russian, published and distributed by Associated Technical Services, Inc., Glen Ridge, N. J. Copyright, 1958, by North American Aviation, Inc. Cloth 8 × 11 in., preface, literature cited, vi and 114 pp., $27.50.

**Reviewed by C. A. Meyer**[1]

THIS book was originally published in Russian in 1955, by the Leningrad Division of MAShGIZ (State Scientific and Technical Publishing House for Literature on Machine Construction) USSR.

The book is intended for scientists and engineers engaged in the design, construction, and testing of turbomachinery. The primary purpose of the book is to outline a method of calculating the fundamental aerodynamic characteristics of actual steam and gas-turbine stages having finite blade lengths and end losses. The two-dimensional flow past cascades has been covered previously by the same author in a special book similarly published in 1952. The present book is divided into two approximately equal parts. The first part, containing six chapters, is devoted to cascades and treats, in succession, profile losses, trailing-edge thickness losses, end loss coefficients, three-dimensional boundary layers on the end wall, empirical methods of calculating end losses, their comparison with experimental data, two-dimensional exit angles in cascades, the effect of blade length on exit angle, and the sequence of end loss calculations.

The second part of the book discusses the complete turbine stage in four chapters, starting with the elementary equations, velocity diagrams, radial equilibrium, and the relation between loss coefficient and stage efficiency.

A comparison of calculated and tested performance is next presented for cylindrical and twisted blading having different mean diameter-blade length ratios. The discrepancies between turbine test and calculation based on cascade data is investigated leading to corrections for the hub and tip velocity profiles in the turbine and for the three-dimensional flow in the boundary layer of the rotating blading. These corrections bring agreement, within test accuracy, between calculation and test.

As one reviews a foreign book he quite naturally searches for new test information and new design methods. Of the 68 references only the last 12 are not Russian. These 12, however, include works by Schlicting, Carter, Howell, and Fogarty on two and three-dimensional boundary layers. The author also refers to 12 of his own previous works, which should contain interesting test data and methods.

The most important contributions of the book, in the reviewer's opinion, deal with the three-dimensional flows in the boundary layers on the end walls of cascades and on the rotating blades.

The book does not consider the design or selection of blade shapes or blade spacing or their relation to blade stress. The starting point is to assume that the velocity distribution on the blade is known from electric analog studies or otherwise and then to calculate blade boundary layers, separation criteria, and profile losses. A comparison with test data shows good correlation of a separation criterion attributed to I. L. Povkh.

A formulation is also obtained on the effect of trailing edge thickness on profile

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loss. The author's formula gives about twice the loss as does Flyugel's formula. Although the author indicates that Flyugel's values lack sufficient justification, it is the reviewer's opinion that Flyugel's formula has been verified by many tests in this country at Westinghouse, General Electric, NASA, and also by tests in England.

All calculations are carried out assuming low Mach numbers. A calculation of the flows at the end walls of a cascade leads to a predicted end loss coefficient, which agrees closely with test results.

The prediction of the flow through the actual turbine blading is accomplished by dividing the blade height into several elemental annuli and using simplified radial equilibrium to set the radial pressure distribution, flow, and efficiency. The over-all performance is obtained by summing over the annulus. This method is quite simple compared to some of the more elaborate methods used in this country which employ electronic computers. These latter methods are not limited by simplifying assumptions on radial equilibrium or curvature of the tip or hub boundaries. Confirmation of these methods have been obtained from radial traverses between the turbine rows giving velocities, flow angles, and efficiencies.

The author in attempting correlation between cascade losses and the complete turbine unfortunately had available only one test series showing the effect of tip leakage on efficiency. As the author states, the leakage loss depends on a whole series of factors. A complete series of leakage tests which were run by the reviewer several years ago confirms the authors' contention and shows the losses to be quite dependent on velocity ratio, and differ between shrouded and tip-clearance blading. Generally, the leakage losses are most conveniently separated from the other losses by running at several clearances and extrapolating to zero per cent leakage area. This has been done by the reviewer for both reaction and impulse blading. These tests indicate that, as the author states, the reaction is also affected by clearance. The lack of more extensive tests has not handicapped the author since the separation of the leakage and other losses appears approximately correct.

This book should be of particular value to turbine designers since it contains additional test information on a separation criterion and on the calculation of end losses and trailing edge losses. The methods of calculating three-dimensional boundary layer flows on end walls and on rotating blades is a valuable portion of the book.

## BOOKS RECEIVED IN LIBRARY

**Matrizen; eine Darstellung für Ingenieure**
By Rudolf Zurmühl. Second edition. 1958, Springer-Verlag, Berlin, Germany. 467 p., $6^1/_2 \times 9^1/_2$ in., bound. DM 33. Designed particularly for engineers, this mathematics text provides effective coverage of matrix calculations. The several chapters deal with the basic transformations, rank and linear dependence, bilinear and quadratic forms, eigenvalue problems, matrix structure, numerical processes for equation solution, and the application of matrix calculations to electrochemistry, vibration problems, adjustment of errors, and other technical fields.

**Modern Materials: Advances in Development and Applications**
Vol. 1, 1958. Edited by Henry H. Hausner. 1958, Academic Press, Inc., New York, N. Y. 402 p., $6 \times 9^1/_4$ in., bound. $12.50. This volume, which is the first in a series, covers a variety of materials and the recent developments in connection with them: zirconium; the semiconductors, germanium and silicon; ceramic engineering materials and their applications; insulating papers for high voltages; glasses required to withstand strong irradiation in nuclear engineering; synthetic rubbers for special purposes; new areas of wood as a structural material; organic and inorganic fibers.

**The Physical Theory of Neutron Chain Reactors**
By Alvin M. Weinberg and Eugene P. Wigner. 1958, University of Chicago Press, Chicago 37, Ill. 801 p., $6^1/_4 \times 9^1/_2$ in., bound. $15. A scholarly account of the mathematical and physical theory underlying the design of nuclear-power reactors. The book is divided into four parts covering the nuclear physics of chain reactors, the transport theory of neutrons, general reactor theory, and heterogeneous reactors. Particular features are the discussions of the new fields of resonance and high-energy reactors, and of heterogeneous reactor physics.

**Project Sherwood: The U. S. Program in Controlled Fusion**
By Amasa S. Bishop. 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass. 216 p., $6^1/_4 \times 9^1/_4$ in., bound. $5.75. This is the first unclassified report on the controlled thermonuclear effort in the United States. Beginning with the basic principles involved in a fusion reaction, it continues with the various methods now being studied to control thermonuclear energy with the hope of eventually producing net power. Methods such as pinch, stellarator, magnetic mirror, and molecular ion ignition are explained. A volume in the Atoms for Peace presentation set.

**Physical Acoustics and the Properties of Solids**
By Warren P. Mason. 1958, D. Van Nostrand Company, Inc., Princeton, N. J. 420 p., $6^1/_4 \times 9^1/_4$ in., bound. $9. An introduction to the uses of wave transmission in solids that discusses both engineering applications and analytical uses. Part 1 deals with basic principles and engineering applications. It begins with transducers used to generate waves in solids and continues with instruments for measuring attenuation, velocity, and characteristic impedances of solids. It concludes with high and low-intensity applications of wave transmission. Part 2 is concerned with analytical uses and presents such topics as phenomenological models for wave propagation, thermal damping, grain scattering, domain motion effects, interstitial diffusion effects, high and low-amplitude dislocation effects, sound transmission in single crystal quartz and glasses, and sound damping by free electrons.

**Reactor Fuel Technology**
Edited by Edwin A. Wiggin. 1958, Atomic Industrial Forum, Inc., New York, N. Y. 120 p., $8^1/_2 \times 11$ in., paper. $5. Papers discussing enriched and natural uranium systems, blanket fuel, metal and alloy elements, oxide elements, zirconium and zircaloys, stainless steels, and aluminum alloys. The papers were delivered at a meeting at St. Petersburg Beach, Fla., in 1958.

**Readings in Linear Programming**
By S. Vajda. 1958, John Wiley & Sons, Inc., New York, N. Y. 99 p., $5^3/_4 \times 8^3/_4$ in., bound. $3. Practical applications of linear programming are worked out in detail so as to provide a clear outline of the basic concepts involved. Among those areas studied are transportation, production scheduling, personnel assignment, ship scheduling, routing aircraft, investment, gasoline blending, and warehousing. Sufficient theory has been included to make the book self-sufficient.

**References on Fatigue, 1957**
Published 1958 by the American Society for Testing Materials, Philadelphia, Pa., 64 p., $8^3/_4 \times 11$ in., paper. $3. A list of references to articles published in 1957 dealing with fatigue of structures and materials. References are so arranged that sheets can be cut apart for filing according to any desired plan. Brief abstracts are included when readily available.

**Report on Elevated-Temperature Properties of Chromium Steels**
Published 1958 as Special Technical Publication No. 228 by the American Society for Testing Materials, Philadelphia, Pa. 113 p., $8^1/_2 \times 11$ in., paper. $4.25. A graphic summary of the elevated-temperature strength properties for chromium steels (12 to 27 per cent). It includes data on tensile strength, yield strength, elongation, rupture, and creep properties. Twenty-three alloys are covered ranging from 12 to 27 per cent chromium.

**Scientific Uses of Earth Satellites**
Edited by James A. Van Allen. Second edition. 1958, University of Michigan Press, Ann Arbor, Mich. 316 p., $7 \times 10^1/_4$ in., bound. $10. The present edition has been enlarged to the extent of almost being a handbook on earth satellites. Those areas most extensively revised are the orbit of a small earth satellite, insolation of the upper atmosphere and of a satellite, meteorological measurements and measurements of the earth's magnetic field from a satellite vehicle, ionospheric structure as determined by a minimal artificial satellite, and measurements of interplanetary dust.

**Solid Fuel Reactors**
Edited by Joseph R. Dietrich and Walter H. Zinn. 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass. 844 p., $6^1/_4 \times 9^1/_4$ in., bound. $10.75. Reviews the basic concepts, present status of development in the United States, and the technical outlook for five projected solid-fuel nuclear-power reactor types. These are the fast-neutron power breeders, heavy water reactors, gas-cooled reactors, organic moderated and cooled reactors, and a thermal reactor for recycling plutonium. The information presented ranges

from well-established experimental, theoretical, and developmental results to analyses intended to provide direction for future work. A volume in the Atoms for Peace presentation set.

**Symposium on Brittle Failure of Rotor Forgings**

Published 1958 by the American Society for Testing Materials, Philadelphia, Pa. 43 p., 6 × 9 in., paper. $2. Papers on the requirements of rotor forgings for turbines and generators, with particular reference to inspection and testing. These were presented at the Special Meeting for Delegates to the World Metals Congress in 1957.

**Symposium on Composition of Petroleum Oils, Determination and Evaluation**

Published 1958 by the American Society for Testing Materials, Philadelphia, Pa. 288 p., 6 × 9¼ in., bound. $5.50. Papers covering three aspects of the subject. The first deals with separation in relation to volatility and adsorption, thermal diffusion, and solvent extraction. The second deals with spectroscopic methods such as infrared, mass spectrometry, and nuclear magnetic resonance. The concluding section deals with general methods and correlation, including chemical treating.

**Symposium on Determination of Gases in Metals**

Published 1958 by the American Society for Testing Materials, Philadelphia, Pa. 59 p., 6 × 9¼ in., bound. $2.25. Discussions on equipment and technique that cover vacuum fusion analysis, as well as methods of determining oxygen content in metals, such as the platinum bath and capillary trap, the bromination-carbon reduction, and the emission spectrographic methods.

**Symposium on Elevated Temperature Strain Gages**

Published 1958 as Special Technical Publication No. 230 by the American Society for Testing Materials, Philadelphia, Pa., 163 p., 6 × 9¼ in., bound. $4.50. Fourteen papers and a panel discussion covering various types of strain gages, including resistance wire, metalfilm, foil, and optical; gage alloys; bonding agents; and temperature compensation techniques. The symposium was sponsored by the Aeronautical Structures Laboratory, Naval Air Material Center in 1957.

**Techniques of Plant Maintenance and Engineering**

Published 1958 by Clapp and Poliak, Inc., New York, N. Y. 211 p., 8½ × 11¼ in., bound. No price given. Conference papers presenting the latest methods and practices in the maintenance field in general and in specific industries and plants of various sizes. Topics covered include welding, electric-power bills, maintenance in small plants, labor relations, preventive maintenance, planning and scheduling, electric motors, sanitation objectives, automation, cost control, and preventing air and water pollution. Proceedings of the Technical Sessions of the Ninth National Plant Maintenance and Engineering Show, 1958.

**Thorium Production Technology**

By F. L. Cuthbert. 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass., 303 p., 6¼ × 9¼ in., bound. $6.50. The entire process of thorium production is studied, beginning with the extraction of thorium from ores to the fabricated thorium slug ready for cladding, prior to use in the reactor. Emphasis is placed on the separation of thorium from impurities, its reduction to metallic form, and fabrication of the metal. In addition, sections are included on physical and chemical properties of thorium, health and safety aspects of thorium production, and analytical and metallurgical testing procedures. A volume in the Atoms for Peace presentation set.

## LIBRARY SERVICES

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

**U. S. Research Reactor Operation and Use**

Edited by Joel W. Chastain, Jr., 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass. 366 p., 6¼ × 9¼ in., bound. $7.50. Studies the research reactor as a means of providing a strong source of neutrons and gamma rays for physical research, irradiation testing, and producing radioactive isotopes. The principal emphasis in the book is on the advantages and disadvantages of different reactors and on the costs of acquiring and operating a research-reactor facility. Each type of research reactor is described in detail and analyzed in relation to specific needs. A volume in the Atoms for Peace presentation set.

**Uranium Ore Processing**

Edited by John W. Clegg and Dennis D. Foley. 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass. 436 p., 6¼ × 9¼ in., bound. $7.50. A description of the technology utilized in extracting uranium from its ores. The book covers preliminary treatments like roasting and physical concentrations, leaching with acid or alkaline reagents, separation of the pregnant leach liquor from the unwanted solid gangue, and recovery of the uranium product from the solution, principally by ion exchange and solvent extraction. Six typical plants are then analyzed in considerable detail to illustrate these processes. The book concludes with minor sources of uranium ore such as shale, lignate, and phosphate rock. A volume in the Atoms for Peace presentation set.

**Acoustics, Noise and Buildings**

By P. H. Parkin and H. R. Humphreys. 1958, Frederick A. Praeger, Inc., New York, N. Y. 331 p., 6 × 10 in., bound. $15. A guidebook to the technical problems of acoustics from the standpoint of both the engineer and the architect. It discusses the behavior of sound in rooms; the design of rooms for speech and for music; the design of radio and TV studios; the design of high-quality speech-reinforcement systems; sound insulation and noise control, including criteria and practice; sound measurement and calculation.

**Aménagement, Utilization et Prix de Revient des Usines Hydrauliques**

By Henri Varlet. 1958, Editions Eyrolles. Paris, France. 211 p., 6½ × 9¾ in., bound. 3,000 fr. This book is the first volume of a treatise on hydraulic engineering. The first part deals with the general mechanics of hydraulic engineering, equipment, analyses of power systems, and various aspects of electrical power. Then the integration of water-power production into the total power production of the country, and problems of conservation of water supply are discussed. The last part deals with economic factors involved in the production and distribution of power.

**Axial Flow Compressors**

By J. H. Horlock. 1958, Butterworth & Company, Ltd., Toronto, Canada. 189 p., 6½ × 10 in., bound. $8. Beginning with a brief review of basic fluid dynamics and thermodynamics, the book continues with a discussion of two-dimensional cascades; pitch line design of compressor stages; calculation of losses, stage efficiencies, and characteristics; compressor testing and instrumentation; supersonic compressors. Extensive references are given.

**Classification and Indexing in Science**

By B. C. Vickery. 1958, Academic Press, Inc., New York, N. Y. 185 p., 5¾ × 8¾, bound. $5.50. This book explores modern techniques of subject analysis. It discusses in detail methods of constructing classification schedules for indexing, in particular the method of "facet analysis," the grouping of terms into conceptual categories which are then subdivided generically. It describes notation for the classified catalog, gives examples of classification schemes, and discusses applications to machine-literature searching.

**Fundamentals of Advanced Missiles**

By Richard B. Dow. 1958, John Wiley & Sons, Inc., New York, N. Y. 567 p., 6¼ × 9¼ in., bound. $11.75. Gives the basic principles determining the performance of guided missiles, ballistic missiles, and space vehicles. Discussed are kinematics of flight, application of fluid mechanics to aerodynamics and propulsion, dynamics, properties of microwaves, application of infrared radiation, radar, guidance, and guided-missile systems. Information is presented from the point of view of theory, experimentation, and typical examples encountered in practice rather than detailed design of missile types.

**Fundamentals of Digital Computers**

By Matthew Mandl. 1958, Prentice-Hall, Inc., Englewood Cliffs, N. J. 297 p., 6¼ × 9¼ in., bound. $9. Following a discussion of fundamentals the author explains computer arithmetic applications, binary counting, and special codes; computer circuitry, including the various gates and the circuitry utilizing them; various storage systems found in modern computers; computer programming, including specific examples of programming applied to commerical units; comprehensive descriptions of representative commerical computers. A concluding section deals with servicing and maintenance factors.

**Grenzschichtforschung**

By H. Görtler. 1958, Springer-Verlag. Berlin, Germany. 411 p., 6¾ × 9¾ in., bound. DM 67.50. A compilation of the lectures and discussions of a conference sponsored by the International Union of Theoretical and Applied Mechanics in August, 1957. Various types of boundary layers—turbulent, laminar, rotating laminar, and thermal—are discussed. There are also papers on the mechanism of boundary-layer transition at subsonic and at supersonic speeds, as well as on mathematical

theory of shear-flow turbulence and the solution of boundary-layer equations. Many of the papers are in English.

**A Handbook on Torsional Vibration**
Compiled by E. J. Nestorides for the British Internal Combustion Engine Research Association. 1958, Cambridge University Press, New York, N. Y. 664 p., $6^1/_4 \times 9^1/_4$ in., bound. $19.50. An extensive work which gives formulas, design procedures, specifications and methods relating to torsional vibration conditions of engines and machines. The four major divisions presented encompass preliminary calculations and measurements, evaluation and prediction of torsional vibration stresses, design and operation of various devices for limiting vibration, and instrumentation. Each subsection on design procedure or testing is self-contained so as to provide maximum usability of the handbook.

**High Temperature Water Systems**
By Owen S. Lieberg. 1958, The Industrial Press, New York, N. Y. 211 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.50. Intended for engineers and contractors this volume contains data used successfully in high-temperature water systems. Design, specification, installation, application, and economics are presented in detail. Specific aspects discussed are pressurizing, boilers and expansion tanks, system control, circulating pumps, valves, piping, and process and space heating. A feature is the complete treatment of the design of a typical system.

**A History of Technology**
Vol. V. The late nineteenth century, c. 1850–c. 1900. Edited by Charles Singer and others. 1958, Oxford University Press, New York, N. Y. 888 p., $8 \times 10^1/_2$ in., bound. $26.90. The importance of applied science and its effect on manufacture and production in the latter half of the nineteenth century is the outstanding theme of the present volume which concludes the series. Also considered is the social effect of scientific industry upon the lives of individuals. Topics presented include primary production, prime movers, the chemical industry, transport, civil engineering, and manufacture.

**Illustrierte Technische Wörterbücher**
Band 1. Maschinenelemente. By Alfred Schlomann. 1958, R. Oldenbourg Verlag, Munich, Germany. 438 p., $7^1/_2 \times 9^3/_4$ in., bound. DM 46. This book is the first volume of a technical dictionary in German, English, Russian, French, Italian, and Spanish and treats of machine parts. Entries are printed in a classified arrangement with brief definitions in each language, and illustrative diagrams for most words. There is an alphabetical key for each language referring to page and to entry numbers. This is a reprint of the third edition, 1938, which has been out of print for some years.

**Man the Maker**
By R. J. Forbes. 1958, Abelard-Schuman, Inc., New York, N. Y. 365 p., $5^3/_4 \times 8^1/_2$ in., bound. $5. A history of technology and engineering in which power resources, transportation, communication, metallurgy, textiles, glass, chemical technology, and some aspects of civil engineering are covered. The inventions of prehistory, of the Ancient East, the Greeks and Romans, the Arabs, the Middle Ages, the sixteenth and seventeenth centuries, the Industrial Revolution, and the modern era are also discussed, as are the relationships of the inventors to each period.

**Modern Safety Practices**
By Russell DeReamer. 1958, John Wiley & Sons, Inc., New York, N. Y. 357 p., $6 \times 9^1/_4$ in., bound. $7. Stresses the need for designing safety programs to conform to modern management practices and newly developed and tested concepts of safety organization and administration. The safety program is presented in four phases: the development of safe working conditions; job hazard analysis and personalized safety training; promotion of employee safety participation; enforcement of safety rules. Among other features, the book outlines consultative methods for safety engineers.

**Nonlinear Problems in Random Theory**
By Norbert Wiener. 1958, John Wiley & Sons, Inc., New York, N. Y. 131 p., $6^1/_4 \times 9^1/_4$ in., bound. $4.50. In this first comprehensive study of the application of random theory to nonlinear processes, a top-rank mathematical analyst examines the role of nonlinear processes in physics, mathematics, electrical engineering, physiology, and communication theory. He demonstrates how random processes—in space as well as in time—enter into the study of statistical mechanisms, a useful approach to new research in gas and plasma theory, for instance.

**Nuclear Engineering Handbook**
Edited by Harold Etherington. 1958, McGraw-Hill Book Company, Inc., New York, N. Y. Various pagings, $6^1/_4 \times 9^1/_4$ in., bound. $25. A comprehensive survey of nuclear theory and of nuclear-engineering principles and techniques. Aspects covered include nuclear data, nuclear physics, experimental techniques, reactor physics, radiation and radiological protection, control of reactors, fluid and heat flow, reactor materials, chemistry and chemical engineering, nuclear-power-plant selection, mechanical design and operation of reactors, and isotopes. The material is presented on a practical level for engineers interested in the industrial uses of nuclear energy.

**The Nuclear Handbook**
Edited by O. R. Frisch. 1958, D. Van Nostrand Company, Inc., Princeton, N. J. Various pagings, $4^3/_4 \times 7$ in., bound. $8.50.

# ASME BOILER AND PRESSURE VESSEL CODE

## Interpretations

THE Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting Feb. 27, 1959, and approved by the Board on April 24, 1959.)

## Annulment of Cases

| Case No. | Reasons for Annulment |
|---|---|
| 941 | Lack of use |
| 1159 | Provisions are included in Par. 1(c) of Specification SA-336 |
| 1171 | Lack of use |
| 1206 | Essence of Case now included in Par. P-268 and Table P-12 |
| 1210 | Intent of Par. P-216 clarified, Case no longer necessary |

## Case No. 1204-4
### *(Reopened) (Special Ruling)*
### (Quenched and Tempered Steel Plate and Forgings)

In the Inquiry, Table 2, revise the Tensile Strength from "105,000 to 135,000" to read "115,000 to 135,000"; revise the Yield Strength from "90,000" to read "100,000."

In the Reply, Par. (4), revise "26,250 psi" to read "28,750 psi."

## Case No. 1223-1
### *(Reopened)*
### (Interpretation of Par. P-108)

In the Inquiry, add ". . . and Par. P-112(c)." to the first sentence.

In the Reply, add ". . . and Par. P-112(c)." to the last sentence of Par. (a).

## Case No. 1258
### *(Special Ruling)*
### (Use of Unalloyed Titanium)

*Inquiry:* Will unfired pressure vessels fabricated by fusion welding under the applicable rules of Section VIII meet the intent of the Code if the base materials are wrought titanium shapes that conform in chemical composition and mechanical properties to ASTM specifica-

Contains condensed and tabulated data needed in research and practical applications of nuclear science. Among the areas covered are particle accelerators, charged particles, x-rays and gamma rays, neutrons, fission product and transuranic elements, reactors, ion chambers and counters, deflection techniques and magnetic materials, cloud and bubble chambers, nuclear emulsions, and nuclear reactions.

**Optimale Stufenrädergetriebe für Werkzeugmaschinen**

By Erwin Stephan. 1958, Springer-Verlag, Berlin, Germany. 102 p., $6^1/_2 \times 9^3/_4$ in., bound. DM 25. This treatise on stepped gears for machine tools shows methods for the rapid determination of the optimum design for any desired application. Part 1 deals with the various types of gears, the calculation of transmission elements, and methods for determination of optimum speed. Part 2 deals with the optimum arrangement of the gears and with the practical applications. Graphical representations are used extensively throughout the book.

**Powder Metallurgy in Nuclear Engineering**

Published 1958 by the American Society for Metals, Cleveland, Ohio. 275 p., $6^1/_4 \times 9^1/_4$ in., bound. $8.50. The 15 papers included in this volume deal with a considerable range of topics: general metallurgical problems in reactor design; preparation of metal powders; alloying by powder metallurgy; fuel materials and elements for reactors; safe handling of pyrophoric and radioactive metal powders; and the powder metallurgy of zirconium, beryllium, uranium, and thorium. Some of the papers were presented at the Conference on Powder Metallurgy in Atomic Energy, held October, 1955, in Philadelphia.

**Punched Cards: Their Applications to Science and Industry**

Edited by Robert S. Casey and others. Second edition. 1958, Reinhold Publishing Corporation, New York, N. Y. 697 p., $6^1/_4 \times 9^1/_4$ in., bound. $15. Beginning with an introduction to the use of a simple punched-card file, the book continues with case histories of punched-card applications including the Peek-a-Boo System, the Uniterm System, mechanized coding and searching techniques applied to the metallurgical literature, the Zato-Coding System, and the use of punched-cards in linguistic analysis as applied to ancient texts such as the Dead Sea Scrolls. This is followed by fundamental considerations in coding and systems design, future possibilities, and an annotated bibliography on the uses of punched cards.

**Richtlinien für die Aufbereitung von Kesselspeisewasser und Kühlwasser**

By the Vereinigung der Grosskesselbesitzer. Fifth edition. 1958, Vulkan-Verlag Dr. W. Classen, Essen, Germany. 267 p., $7 \times 9^1/_2$ in., bound. DM 46. Rules for construction of various types of installations for treating boiler feedwater. Methods for the analysis of water are included as well as mathematical procedures and tables for the determination of feedwater characteristics. This fifth edition incorporates new theoretical and practical developments, with particular attention to methods for complete salt removal. ●

## SPECIFICATION B 265-58T

| | Grade 1 | Grade 2 | Grade 3 |
|---|---|---|---|
| Nitrogen, max, per cent | 0.05 | 0.05 | 0.07 |
| Carbon, max, per cent | 0.10 | 0.10 | 0.10 |
| Iron, max, per cent | 0.20 | 0.20 | 0.30 |
| Hydrogen, max, per cent | 0.015 | 0.015 | 0.015 |
| Oxygen, max, per cent | 0.25 | 0.25 | 0.35 |
| Titanium, per cent | Remainder | Remainder | Remainder |
| Tensile Strength, psi | | | |
| Annealed min | 40,000 | 50,000 | 60,000 |
| Yield Strength (0.2 per cent offset) | | | |
| Annealed min | 30,000 | 40,000 | 50,000 |
| Annealed max | 55,000 | 65,000 | 75,000 |
| Elongation in 2-in., min, per cent | 22 | 20 | 18 |

tions for Grades 1, 2, and 3 of B 265-58T? Grades 1, 2 and 3 are submitted at this time only for internal pressure applications.

*Reply:* It is the opinion of the Committee that unalloyed titanium as specified in the Inquiry may be used in the construction of welded pressure vessels under the rules of Section VIII, subject to the following requirements:

(1) *Materials* The various product forms shall meet all the applicable requirements of the following specifications, except that the chemical and mechanical requirements shall be those stated in the inquiry:

| | |
|---|---|
| Plate | B 265-58T |
| Forgings | SA-182 |
| Rod and Bar | A 276-57T |
| Pipe | B 337-58T |
| Tubes | B 338-58T |

(2) *Welding* (a) Fabrication is to be by inert-gas shielded metal-arc welding, (consumable or tungsten electrode) meeting the applicable requirements of Section VIII including Part UNF of Subsection C and Part B of Section IX. In the procedure and performance qualifications, the longitudinal bend test may be employed.

(b) The tensile strength of the reduced section specimen shall not be less than the minimum specified tensile strength of the base metal.

(c)(1) Procedure and performance qualification on titanium Grades 1 or 2 qualifies for either Grades 1 or 2.

(2) Procedure and performance qualification on Grade 3 titanium qualifies for Grades 1, 2, and 3.

(3) The performance qualification requirements for welding operators shall be the same as those for welders.

(d) Filler metal, where used, shall comply in composition with Grades 1 or 2. The resultant welds shall meet the weld test requirements in Section IX, Part B, for the grade of base metal used.

(e) All longitudinal and circumferential main joints shall be double butt-welded or equivalent.

(f) Titanium shall not be arc welded to other metals.

(3) *Inspection* (a) In addition to the customary inspection requirements of the applicable portions of the Code, all butt-welded joints shall be fully radiographed as prescribed in Par. UW-51, *and all other joints that are not radiographed shall be liquid penetrant oil inspected.*

(b) If a vessel incorporates main longitudinal or circumferential joints, a production test plate of the same specification, grade, and thickness shall be made of sufficient size to provide at least one face and one root bend specimen. Where longitudinal joints are involved, the test plate shall be attached to one end of the longitudinal joint and welded continuously with the joint. Where circumferential joints only are involved, the test plate need not be attached but shall be welded along with the joint. One test plate is required for each vessel by each welder working on the vessel, provided not over 100 feet of main joints are involved. An additional test plate shall be made for each additional 100 feet of main joint. The bend specimens shall be tested in accordance with Section IX, Pars. QN-7 and QN-8. Failure of either bend specimen constitutes rejection of the weld.

(4) *Stress Values* The following maximum allowable stress values are to be used in applying the design rules where reference is made to Table UNF-23:

| | For Metal Temperatures Not Exceeding Deg F | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 70 | 100 | 200 | 300 | 400 | 500 | 600 | 650 |
| Grade 1 | 10,000 | 9,600 | 7,950 | 6,500 | 5,500 | 4,700 | 4,000 | 3,750 |
| Grade 2 | 12,500 | 12,000 | 10,400 | 8,900 | 7,900 | 7,000 | 6,250 | 5,950 |
| Grade 3 | 15,000 | 14,000 | 11,400 | 9,600 | 8,250 | 7,150 | 6,400 | 6,100 |
| Grade 3 Bolting only | 12,000 | 11,250 | 9,150 | 7,700 | 6,600 | 5,700 | 5,100 | 4,850 |

(5) *Stress Relief* Stress relieving, although not mandatory after welding, is recommended after forming operations. Stress relief shall be done in a furnace at a temperature of 900 to 1000 F, with time at temperature not to exceed 45 minutes.

*Cautionary Notes:* (1) In certain environments associated with pickling and annealing, as well as under actual operating conditions, absorption of hydrogen with resultant embrittling of the titanium may occur. Scaling may result from excessive annealing time and temperatures in oxidizing environments, and reducing furnace atmospheres shall not be used. Suitable procedures are available from the manufacturers and other sources to minimize scaling or hydrogen pickup during the various steps associated with fabrication. Service environments should be considered from the standpoints of potential hydrogen embrittlement, oxide scaling, and rapid oxidation.

(2) Molten or very hot titanium reacts readily with air. Contamination during welding by oxygen and nitrogen increases the weld-metal hardness and decreases the ductility and notch toughness. An increase in weld-metal hardness (in comparison with parent-metal hardness) of more than about 40 VHN is indicative of possible excessive contamination. Substantial increase in hardness above this amount necessitates removal of the affected weld-metal area.

(3) Special precautions should be taken to insure complete inert-gas shielding of the weld metal pool, the weld face, the back side of the weld, and the adjacent heat-affected base metal surfaces. Close supervision and inspection throughout the welding operation, as well as inspection of the weld face after the completion of each pass, prior to brushing or cleaning, is desirable.

(4) For sub-zero applications (as, for example, in containers for liquified gases) only material of Grades 1 or 2 should be used, in order to obtain adequate notch toughness.

## Case No. 1263
### *(Special Ruling)*
### (Plain and corrugated furnace)

*Inquiry:* Pars. P-239, P-240, and P-241 give rules for construction of plain circular furnaces. Par. P-243 gives rules for construction of corrugated furnaces. Both types are under external pressure. Is it permissible to construct a furnace under Code rules combining a plain circular section and a corrugated section for use under external pressure?

*Reply:* Furnaces for external pressure may be constructed by combining a plain circular section and a corrugated section provided:

(1) Each type of furnace is designed to be self-supporting, requiring no support from the other furnace at their point of connection.

(2) Pars. P-240 and P-241 shall be used for calculating the maximum allowable working pressure of the plain section. In applying the length in the text, or L in the formulas, the figure used shall always be twice the actual length of the plain section. The actual length of the plain section is the distance measured from the centerline of the head attachment weld to the centerline of the full penetration weld joining the two sections.

*Furnaces 12 in. to 18 in. in outside diameter inclusive:*

A plain furnace section whose length is such that twice the actual length does not exceed $4^1/_2$ diameters shall have its maximum allowable working pressure calculated by formulas (1) or (2) in Par. P-240 (1). If twice the actual length of the plain furnace section does not exceed 120 times the thickness of the plate, formula (1) shall be used. If twice the actual length of the plain furnace section exceeds 120 times the plate thickness, formula (2) shall be used.

A plain furnace section whose length is such that twice the actual length exceeds $4^1/_2$ diameters shall have its maximum allowable working pressure determined in accordance with Par. P-241.

*Furnaces over 18 in. to and including 38 in. in outside diameter:*

The maximum allowable working pressure of a plain furnace section shall be determined by formulas (1) and (2), Par. P-241 (1). When twice the actual length of the plain furnace section exceeds the maximums of Par. P-240 (3), (6), and (8), L in the formulas shall be taken as six times the diameter.

(3) The maximum allowable working pressure of the corrugated section shall be determined from Par. P-243.

(4) The full penetration weld joining a plain self-supporting section to a corrugated self-supporting section shall be located not more than $1^1/_2$ in. or three times the thickness of the corrugated section (whichever is smaller), not less than $^3/_4$ in., from the point of tangency of the plain section and the corrugated section; see Fig. P-31 (b).

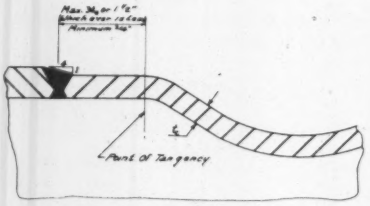



Fig. P. 31(b)

## Case No. 1264
### *(Special Ruling)*
### Type 403 Forging Modified Material

*Inquiry:* May seamless steel forgings or bars conforming to the following chemical analysis and having minimum specified mechanical properties shown below be used in pressure vessels conforming to the requirements of Section I or Section VIII of the Code as supplemented by Case 1234?

(1) Chemistry (AISI—Type 403 Modified)

| | PER CENT |
|---|---|
| Carbon | 0.06 to 0.13 |
| Manganese | 0.25 to 0.80 |
| Phosphorus | 0.03 max |
| Sulfur | 0.03 max |
| Chromium | 11.50 to 13.00 |
| Nickel | 0.50 max |
| Silicon | 0.50 max |

(2) Mechanical properties in the annealed condition as received conform to the following requirements.

| | |
|---|---|
| Tensile strength | 70,000 psi, min |
| Yield Strength | 40,000 psi, min |
| Elongation in 2 in. | 22.0 per cent, min |
| Reduction of area | 50.0 per cent, min |

(3) Mechanical properties after a heat-treatment consisting of heating to 1775 to 1825 F followed by air cooling, or quenching in a salt bath at 1025 to 1075 F and air cooled, and then tempered at 1125 F minimum for four (4) hours conforming to the following requirements:

| | |
|---|---|
| Tensile strength | 110,000 psi, min |
| Yield strength | 90,000 psi, min |
| Elongation in 2 in. | 16.0 per cent, min |
| Reduction on area | 50.0 per cent, min |
| Rockwell C hardness | 22 to 29 |
| Brinell hardness | 235 to 277 |

*Reply:* It is the opinion of the Committee that this material may be used for the construction of pressure vessels under the rules of Section I or Section VIII of the Code as supplemented by Case 1234 provided the following additional requirements are met:

(1) The material shall conform to all other requirements of SA-182, Grade F6, for forgings, and ASTM A 276 for bars.

(2) The maximum inside diameter of the shell is 8 in.

(3) The maximum operating temperature shall not exceed 650 F.

(4) Allowable stresses as shown in

Table 1 below for the heat-treated condition may be used when the material has enhanced properties due to the special heat treatment described in the Inquiry.

(5) Where the method of fabrication requires welding after heat-treatment, it shall be done by applying austenitic chromium-nickel steel or chromium-nickel weld deposits prior to heat-treatment and only on regions designed to the allowable stresses shown in Table 1 below for annealed properties. The minimum thickness of this weld shall be $^3/_{16}$ in. and the maximum $^1/_2$ in. Such weld deposits shall be liquid penetrant inspected. Attachments to these austenitic weld deposits may be made by austenitic welding subsequent to heat-treatment, and the thickness shall not exceed that of the previously deposited weld. No welding on the ferritic base metal is permitted after heat-treatment and no welding is permitted at any time in the regions designed to allowable stresses higher than those given in Table I for annealed properties. All welding shall meet the requirements of Section IX, except that the tests shall be made after final heat-treatment of the specimen and longitudinal bend test specimen of Part B, Section IX may be used.

(6) Machined transitions between adjoining heavy and thin walled sections shall consist of a taper of at least 4 to 1, with a radius at each end of at least twice the thickness of the thin wall.

(7) All heat-treated parts shall be inspected for quench cracks by a liquid penetrant method. All cracks shall be removed and a crack which cannot be removed within the minimum required thickness of the shell is cause for rejection.

(8) Hardness checks shall be made after heat-treatment at not more than 5 foot intervals with a minimum of three different locations representing approximately the center and each end. The average of individual hardness readings at each location shall not be less than 235 Brinell nor more than 277 Brinell.

TABLE 1—ALLOWABLE STRESSES, PSI

| | −20 to 100 F | 300 F | 500 F | 650 F |
|---|---|---|---|---|
| Heat-treated | 27,500 | 24,750 | 23,350 | 22,000 |
| Annealed | 17,500 | 16,300 | 15,100 | 14,300 |

*Note:* It is anticipated that this material is intended for severe services requiring premium quality materials. The above represent minimum requirements and the design engineer is expected to require such additional requirements for design, material testing, and fabrication inspection as is considered necessary to meet the demands of the intended service.

## Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

AS NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the semi-annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

### *Power Boilers, 1956*

PAR. P-242 Add new subparagraph (c) as follows:

(c) Combination Type Furnaces for external pressure may be constructed by combining a plain circular section and a corrugated section provided:

(1) Each type of furnace is designed to be self-supporting, requiring no support from the other furnace at their point of connection.

(2) Pars. P-240 and P-241 shall be used for calculating the maximum allowable working pressure of the plain section. In applying the length in the text, or L in the formulas, the figure used shall always be twice the actual length of the plain section. The actual length of the plain section is the distance measured from the centerline of the head attachment weld to the centerline of the full penetration weld joining the two sections.

*Furnaces 12 in. to 18 in. in outside diameter inclusive:*

A plain furnace section whose length is such that twice the actual length does not exceed $4^1/_2$ diameters shall have its maximum allowable working pressure calculated by formulas (1) or (2) in Par. P-240 (1). If twice the actual length of the plain furnace section does not exceed 120 times the thickness of the plate, formula (1) shall be used. If twice the actual length of the plain furnace section exceeds 120 times the plate thickness, formula (2) shall be used.

A plain furnace section whose length is such that twice the actual length exceeds $4^1/_2$ diameters shall have its maximum allowable working pressure determined in accordance with Par. P-241.

*Furnaces over 18 in. to and including 38 in. in outside diameter:*

The maximum allowable working pressure of a plain furnace section shall be determined by formulas (1) and (2), Par. P-241 (1). When twice the actual length of the plain furnace section exceeds the maximums of Par. P-240 (3), (6), and (8), L in the formulas shall be taken as six times the diameter.

(3) The maximum allowable working pressure of the corrugated section shall be determined from Par. P-243.

(4) The full penetration weld joining a plain self-supporting section to a corrugated self-supporting section shall be located not more than $1^1/_2$ in. or three times the thickness of the corrugated section (whichever is smaller), nor less than $^3/_4$ in., from the point of tangency of the plain section and the corrugated section; see Fig. P-31 (b).

### Low-Pressure Heating Boilers, 1956

PAR. H-68 Add the following as a new subparagraph:

(g) Applicants for an "A" symbol to be used only in the field assembly of heating boilers shall so state on the application form, and the Certificate of Authorization issued to such applicants shall show that the authorization to use the "A" symbol is limited to the field assembly of welded steel boilers constructed to Section IV.

### Unfired Pressure Vessels, 1956

PAR. UCS-67(b) Revise to read:

(b) All main seams in vessels of welded construction shall be of the double butt-welded or equivalent type when required by Par. UW-2(b).

PAR. UCI-101(a) Delete the first sentence and replace with the following:

(a) The maximum allowable working pressure of identical cast iron vessels or vessel parts, based on testing one of them to destruction, limited to the service conditions specified in Par. UCI-3 and in accordance with Par. UG-101(m) shall be: (the remainder of Par. UCI-101(a) to stand as now written).

Revise (b) to read as follows:

(b) All vessels or vessel parts of the same material, design and construction, whose maximum allowable working pressure is based on a test to destruction of a sample vessel in accordance with (a) above, shall be considered to have a design pressure equal to the maximum allowable working pressure thus determined, except as limited by the rules of Par. UCI-3, and shall be subjected to a hydrostatic test pressure in conformity with the rules of Par. UCI-99.

TABLE UNF-23, Nickel and High Nickel Alloys Replace present table with revised table.

## TABLE UNF-23—NICKEL AND HIGH NICKEL ALLOYS

| Material, Form, and Specification No. | Condition | Specified Tensile Strength, psi. | Min. Yield Strength 0.2% Offset | For Metal Temperature Not Exceeding, °F | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 |
| **Nickel** | | | | | | | | | | | | | | | |
| Bar, Rods, Shapes and Forgings | | | | | | | | | | | | | | | |
| SB-160 | Hot or Cold Worked - Annealed | 55000 | 15000 | 10000 | 10000 | 10000 | 10000 | 10000 | 10000 | | | | | | |
| SB-160 | Hot Rolled or Forged - Hot Finished | 60000 | 15000 | 10000 | 10000 | 10000 | 10000 | 9500 | 8300 | | | | | | |
| Bolting | | | | | | | | | | | | | | | |
| SB-160 | Hot or Cold Worked - Annealed | 55000 | 15000 | 1700 | 1700 | 1700 | 1700 | 1700 | 1700 | | | | | | |
| SB-160 | Hot Rolled or Forged - Hot Finished | 60000 | 15000 | 1700 | 1700 | 1700 | 1700 | 1700 | 1400 | | | | | | |
| SB-160 | Cold Drawn - All Sizes - All Products | 65000 | 40000 | 10000 | 9600 | 9600 | 9600 | 9500 | 9200 | | | | | | |
| Pipe or Tube | | | | | | | | | | | | | | | |
| SB-161 | Seamless - Annealed - 5" OD and Under | 55000 | 15000 | 10000 | 10000 | 10000 | 10000 | 10000 | 10000 | | | | | | |
| SB-161 | Seamless - Annealed - Over 5" OD | 55000 | 12000 | 8000 | 8000 | 8000 | 8000 | 8000 | 8000 | | | | | | |
| SB-161 | Seamless - Stress Relieved - All Sizes (1) | 65000 | 40000 | 16200 | 15300 | 15000 | 15000 | 14500 | | | | | | | |
| Condenser Tube | | | | | | | | | | | | | | | |
| SB-163 | Seamless - Annealed | 55000 | 15000 | 10000 | 10000 | 10000 | 10000 | 10000 | 10000 | | | | | | |
| SB-163 | Seamless - Stress Relieved (1) | 65000 | 40000 | 16200 | 15300 | 15000 | 15000 | 14500 | | | | | | | |
| Plate, Sheet or Strip | | | | | | | | | | | | | | | |
| SB-162 | Hot or Cold Rolled - Annealed | 55000 | 15000 | 10000 | 10000 | 10000 | 10000 | 10000 | 10000 | | | | | | |
| SB-162 (Plate Only) | Hot Rolled - As Rolled | 55000 | 20000 | 13300 | 13300 | 13300 | 13300 | 12500 | 11500 | | | | | | |
| **Low Carbon Nickel** | | | | | | | | | | | | | | | |
| Bar, Rods, Shapes and Forgings | | | | | | | | | | | | | | | |
| SB-160 | Annealed or Hot Finished - All products, all sizes | 50000 | 10000 | 6700 | 6400 | 6300 | 6200 | 6200 | 6200 | 6200 | 5900 | 4500 | 3000 | 2000 | 1200 |
| Bolting | | | | | | | | | | | | | | | |
| SB-160 | Annealed or Hot Finished - All products, all sizes | 50000 | 10000 | 2500 | 2400 | 2300 | 2300 | 2300 | 2300 | 2300 | 2200 | 2100 | 2000 | 1800 | 1200 |
| Pipe or Tube | | | | | | | | | | | | | | | |
| SB-161 | Seamless - Annealed - 5" OD and Under | 50000 | 12000 | 8000 | 7700 | 7500 | 7500 | 7500 | 7500 | 7400 | 7200 | 4500 | 3000 | 2000 | 1200 |
| SB-161 | Seamless - Annealed - Over 5" OD | 50000 | 10000 | 6700 | 6400 | 6300 | 6200 | 6200 | 6200 | 6200 | 5900 | 4500 | 3000 | 2000 | 1200 |
| SB-161 | Seamless - Stress Relieved - All sizes (1) | 60000 | 30000 | 19000 | 14200 | 13800 | 13500 | 13500 | | | | | | | |
| Condenser Tube | | | | | | | | | | | | | | | |
| SB-163 | Seamless-Annealed | 50000 | 12000 | 8000 | 7700 | 7500 | 7500 | 7500 | 7500 | 7400 | 7200 | 4500 | 3000 | 2000 | 1200 |
| SB-163 | Seamless - Stress Relieved | 60000 | 30000 | 19000 | 14200 | 13800 | 13500 | 13500 | 13000 | 12000 | 11000 | 10000 | | | |
| Plate, Sheet or Strip | | | | | | | | | | | | | | | |
| SB-162 | Hot Rolled and Hot or Cold Rolled - Annealed | 50000 | 12000 | 8000 | 7700 | 7500 | 7500 | 7500 | 7500 | 7400 | 7200 | 4500 | 3000 | 2000 | 1200 |
| **Nickel-Copper (Monel)** | | | | | | | | | | | | | | | |
| Bar, Rods, Shapes and Forgings | | | | | | | | | | | | | | | |
| SB-164 (Class A and B) | Hot or Cold Worked - Annealed - All sizes, all products | 70000 | 25000 | 16600 | 16400 | 13600 | 13200 | 13100 | 13100 | 13100 | 13100 | 8000 | | | |
| SB-164 (Class A only) | Hot Finished - All sizes except Hex. over 2-1/8" | 80000 | 40000 | 20000 | 18900 | 18400 | 18200 | 18200 | 18200 | 17600 | 14500 | 4000 | | | |
| SB-164 (Class A only) | Hot Finished - Hex. over 2-1/8" | 75000 | 30000 | 18700 | 17700 | 17200 | 17100 | 17100 | 17100 | 16300 | 14500 | 4000 | | | |
| SB-164 (Class B only) | Hot Finished Rounds to 3" Incl. | 75000 | 35000 | 18700 | 17700 | 17200 | 17100 | 17100 | 17100 | 16300 | 14500 | 4000 | | | |
| SB-164 (Class A only) | Hot Finished - Stress Relieved - 4" to 12" Dia. Incl. | 80000 | 40000 | 20000 | 18900 | 18400 | 18200 | 18200 | 18200 | 17600 | 14500 | 4000 | | | |
| SB-164 (Class A only) | Hot Finished - Stress Relieved - Over 12" Dia. | 75000 | 40000 | 18700 | 17700 | 17200 | 17100 | 17100 | 17100 | 16300 | 14500 | 4000 | | | |
| Bolting | | | | | | | | | | | | | | | |
| SB-164 (Class A and B) | Annealed - All products, all sizes | 70000 | 25000 | 6100 | 5700 | 5300 | 5000 | 4900 | 4900 | 4900 | 4900 | 4700 | | | |
| SB-164 (Class A only) | Hot Finished - All sizes except Hex. over 2-1/8" | 80000 | 40000 | 10200 | 9600 | 9200 | 9000 | 8500 | 8500 | 8500 | 8300 | 4000 | | | |
| SB-164 (Class A only) | Hot Finished - Hex. over 2-1/8" | 75000 | 30000 | 7500 | 7400 | 7100 | 6800 | 6500 | 6500 | 6400 | 6200 | 4000 | | | |
| SB-164 (Class B only) | Hot Finished Rounds to 3" Dia. Incl. | 75000 | 35000 | 8800 | 8300 | 8100 | 7900 | 7900 | 7600 | 7500 | 7300 | 4000 | | | |
| SB-164 (Class A only) | Cold Drawn - Stress Relieved - All sizes (1) | 84000 | 50000 | 12500 | 11900 | 11500 | 11300 | 11300 | | | | | | | |
| SB-164 (Class A only) | Cold Drawn - Stress Equalized - Rounds to 3-1/2" Incl. (1) | 90000 | 70000 | 17400 | 16900 | 16200 | 15900 | 15400 | | | | | | | |
| SB-164 (Class A only) | " " " - Other Sizes & Shapes (1) | 85000 | 55000 | 13700 | 13000 | 12600 | 12400 | 12300 | | | | | | | |
| SB-164 (Class A only) | Cold Drawn - As Drawn - All sizes (1) | 85000 | 55000 | 13700 | 13000 | 12600 | 12400 | 12300 | | | | | | | |
| SB-164 (Class B only) | Cold Drawn - As Drawn - All sizes (1) | 85000 | 50000 | 12400 | 12000 | 11500 | 11100 | 11100 | | | | | | | |
| Pipe or Tube | | | | | | | | | | | | | | | |
| SB-165 | Seamless - Annealed - 5" OD and Under | 70000 | 28000 | 17500 | 16900 | 15500 | 14800 | 14700 | 14700 | 14700 | 14500 | 8000 | | | |
| SB-165 | Seamless - Annealed - Over 5" OD | 70000 | 25000 | 16600 | 16400 | 13600 | 13200 | 13100 | 13100 | 13100 | 8000 | | | | |
| SB-165 | Seamless - Stress Relieved, All sizes (1) | 85000 | 55000 | 21200 | 20200 | 19500 | 19200 | 19200 | (1) | | | | | | |
| Condenser Tube | | | | | | | | | | | | | | | |
| SB-163 | Seamless - Annealed - all sizes to 3" incl. | 70000 | 28000 | 17500 | 16900 | 15500 | 14800 | 14700 | 14700 | 14700 | 14500 | 8000 | | | |
| SB-163 | Seamless - Stress Relieved - 1/2" to 7/8" dia. incl. | 90000 | 55000 | 22500 | 21200 | 20700 | 20500 | 20500 | 19500 | 19000 | 18500 | (2) | | | |
| SB-163 | Seamless - Stress Relieved - other sizes | 85000 | 55000 | 21200 | 20200 | 19500 | 19200 | 19200 | 19200 | 18500 | 19000 | (2) | | | |
| Plate, Sheet or Strip | | | | | | | | | | | | | | | |
| SB-127 | Hot or Cold Rolled - Annealed | 70000 | 28000 | 17500 | 16900 | 15500 | 14800 | 14700 | 14700 | 14700 | 14500 | 8000 | | | |
| SB-127 (Plate only) | Hot Rolled - As Rolled | 75000 | 40000 | 18700 | 17500 | 17000 | 17000 | 17000 | 17000 | 16500 | 14500 | 4000 | | | |
| **Nickel-Chromium-Iron (Inconel)** | | | | | | | | | | | | | | | |
| Bar, Rods, Shapes and Forgings | | | | | | | | | | | | | | | |
| SB-166 | Hot or Cold Worked - Annealed | 80000 | 30000 | 20000 | 18600 | 18000 | 18000 | 18000 | 18000 | 17500 | 17000 | 16000 | 7000 | 3000 | 2000 |
| SB-166 | Hot Finished - All sizes | 85000 | 35000 | 21200 | 20200 | 20000 | 20000 | 20000 | 20000 | 20000 | 20000 | 19400 | 14500 | 7200 | 5500 |
| Bolting | | | | | | | | | | | | | | | |
| SB-166 | Hot or Cold Worked - Annealed - All sizes | 80000 | 30000 | 7300 | 6900 | 6800 | 6800 | 6800 | 6800 | 6800 | 6500 | 6300 | 6000 | 3000 | 2000 |
| SB-166 | Hot Finished - Rounds over 3" and Shapes - All sizes | 85000 | 35000 | 8700 | 8500 | 8200 | 8200 | 7900 | 7900 | 7900 | 7700 | 7400 | 7300 | 7200 | 5500 |
| SB-166 | Hot Finished - Rounds to 3" Incl. | 85000 | 45000 | 10000 | 9500 | 9200 | 9100 | 9100 | 9100 | 8900 | 8800 | 8600 | 8500 | 7300 | 5500 |
| SB-166 | Cold Drawn - All sizes (3) (4) | 90000 | 40000 | 10000 | 9500 | 9200 | 9100 | 9100 | | | | | | | |
| Pipe or Tube | | | | | | | | | | | | | | | |
| SB-167 | Seamless - Annealed - 5" OD and Under | 80000 | 30000 | 20000 | 18600 | 18000 | 18000 | 18000 | 18000 | 17500 | 17000 | 16000 | 7000 | 3000 | 2000 |
| SB-167 | Seamless - Annealed - Over 5" OD | 80000 | 25000 | 16600 | 16200 | 15800 | 15300 | 15000 | 14900 | 14700 | 14400 | 13900 | 7000 | 3000 | 2000 |
| Condenser Tube | | | | | | | | | | | | | | | |
| SB-163 | Seamless - Annealed - All sizes to 3" incl. | 80000 | 30000 | 20000 | 18600 | 18000 | 18000 | 18000 | 18000 | 17500 | 17000 | 16000 | 7000 | 3000 | 2000 |
| Plate, Sheet or Strip | | | | | | | | | | | | | | | |
| SB-168 | Hot or Cold Rolled - Annealed | 80000 | 30000 | 20000 | 18600 | 18000 | 18000 | 18000 | 18000 | 17500 | 17000 | 16000 | 7000 | 3000 | 2000 |
| SB-168 (Plate only) | Hot Rolled - As Rolled | 85000 | 35000 | 21200 | 20200 | 20000 | 20000 | 20000 | 20000 | 20000 | 20000 | 19400 | 14500 | 7200 | 5500 |

NOTES:

(1) The maximum operating temperature is arbitrarily set at 500 F, because harder temper adversely affects design stress in the creep-rupture temperature range.

(2) 2,000 psi at 900 F, use annealed condition above 800 F.

(3) Design stresses for the cold drawn temper based on hot rolled properties until required data on cold drawn is submitted.

(4) See Pars. UNF-12 and UNF-23.

## Welding Qualifications, 1956

PARS. Q-11 and QN-11, V-7 Delete the word "metal" from "in metal arc welding." Revise the number of V-11 to V-12(a), and add a new V-11 as follows:

A change from the nonconsumable electrode process to the consumable electrode process or vice versa.

Add V-12(b) to read as follows:

When the root pass of combination welds are made by one process and the remaining portion of the groove is completed by another process.

PARS. Q-21 and QN-21 Add subparagraph (c) reading as follows:

Welds requiring a combination of processes may be performed by one or more welders or welding operators. Each, however, may do only that portion of the weld for which he has been qualified.

PARS. Q-22(W-6) and QN-22(W-5) Revise to read as follows:

(a) A change from one welding proess to any other welding process or a combination of welding processes.

(b) Where a combination of welding processes is required to make a weldment, each welder or welding operator must be qualified for the particular welding process he will be required to perform in production welding.

(c) A change from any nonconsumable process to any consumable electrode process or vice versa.

(d) Where combination welds are used, the welder or welding operator who is to make the root pass shall be tested only by means of a minimum of two root bends instead of the face bends and side bends listed in Table Q-(QN)-24.

PAR. QN-22 Add the following note:

Welder or welding operator performance qualifications on aluminum alloys is accomplished by welding any one of the aluminum alloys shown in Table QN-11.1.

TABLE QN-11.1 Add the note as given in Par. QN-22 above. ●

Current Engineering Events, News and Comment

E. S. NEWMAN
News Editor

# THE ROUNDUP

## Nuclear Congress Stresses Peaceful Uses of Atomic Energy

EUROPEAN reactors—in operation or under construction in the United Kingdom and largely in the developmental stages on the continent—played a prominent part among the many aspects of the peaceful uses of atomic energy that were presented at the Fifth Nuclear Congress. The 1959 Congress, co-ordinated by Engineers Joint Council, was an assembly of three conferences and the AtomFair, an exposition of the latest atomic developments, at Cleveland, Ohio, April 5–10.

Preprints of 109 of the papers presented were available for the Nuclear Engineering and Science Conference, which had an attendance of 777 and was sponsored by 27 engineering and scientific societies of the United States and Canada.

The Seventh Hot Laboratories and Equipment Conference was sponsored by an independent group of technologists in atomic laboratories and had an attendance of 341. The proceedings of the seven sessions dealing with the specialized problems of handling radioactive materials and the associated facilities were published in advance in a bound volume.

The Seventh Atomic Energy in Industry Conference was sponsored and conducted by the National Industrial Conference Board. Sessions, largely of the round-table-discussion type, were held on international developments in atomic energy, the sales opportunities in Euratom, the profits and commercial future of radioisotope utilization, and health and safety aspects of the nuclear industry. The latest prospects for a more economical fuel cycle and economic nuclear power, potential peaceful uses of nuclear weapons, and an over-all consideration of the U. S. Power Reactor Program were also discussed.

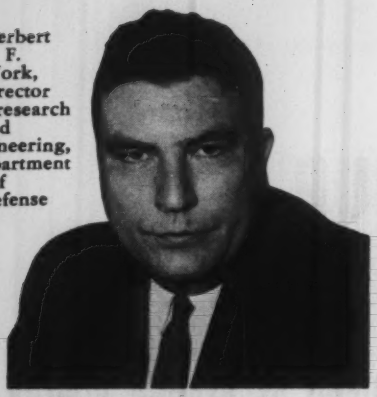
### Luncheons

At a luncheon of the Nuclear Energy Writers Association, held in conjunction with the Congress, John W. Simpson, Mem. ASME, vice-president, Westinghouse Electric Corporation, spoke on "Atomic Power, the Nuclear Navy, and Bettis Laboratory." He described some of the contributions of this ten-year-old laboratory to nuclear-energy development. These include the design of the pressurized-water reactor for Shippingport, submarine prototype and operating reactors, and a prototype reactor for Naval surface craft. Materials, fuel-element, and component-development contributions have also been extensive.

Nobel Prizewinner Arthur H. Compton, professor of natural philosophy, Washington University, St. Louis, Mo., who directed the work which led to the first successful self-sustained nuclear chain reaction while he was at the University of Chicago, spoke of "Science and Man's Destiny" at the American Institute of Chemical Engineers luncheon. He stated that: "There is increasing reason to believe that our technical developments may have already rendered obsolete the appeal to war as a means of settling international disputes. The rapid rate at which the growth of science and technology is bringing about social changes that demand international co-operation, with growing recognition that our future depends on working together for what has become our common well being, gives us ground for hope that before major war again breaks out, the forces of peace will have made unthinkable the organized attack of nation on nation."

Nestore B. Cacciapuoti, scientific and nuclear counselor, Italian Embassy, Washington, D. C., spoke on "Nuclear Power Development in Italy" at a luncheon sponsored jointly by The American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Portions of Dr. Cacciapuoti's

**Cutting the tape with a remote-handling mechanism to open the AtomFair**



Herbert F. York, director of research and engineering, Department of Defense

Nuclear products exhibit of Alco Products, Inc.

Canadian exhibit at the Atom-Fair

talk, available as preprint No. 66, will appear in a subsequent issue of MECHANICAL ENGINEERING.

Miles C. Leverett, manager, development laboratories, General Electric Company, spoke on "Standards for the Nuclear Industry" at the American Nuclear Society luncheon. Pointing to hampering and unrealistic legislation that has been proposed or passed in several states, Mr. Leverett urged engineers to participate in the standards activities of their own societies. He also said that they should take an active interest in the nuclear activities of governmental and regulatory bodies "to see that they make use of the best professional opinions in formulating the laws which they expect our industry to observe in the future."

He spoke of the activities of ASME, "well known for the ASME Boiler Code as well as related codes for Pressure Piping and Unfired Pressure Vessels," and of the co-ordinating work of the American Standards Association in the nuclear field. He outlined some of the work of the ASA's Nuclear Standards Boards and its committees.

At the Atomic Energy in Industry Luncheon of the National Industrial Conference Board, Frederico Consolo, director, economics and industry division of Euratom, discussed the first year of operation of that six-nation body.

Euratom, whose agreement with the U. S. provides for the construction in the six Euratom countries of six to eight nuclear power plants with a total capacity of about 1000 mw at a cost of $350 million, has already undertaken research on high-flux materials-testing reactors and heavy-water prototype reactors, and set up a central bureau for nuclear measurements. Preliminary work is in progress for the establishment of a common center for nuclear research.

At the same luncheon, Pierre Huet, director of the European Nuclear Energy Agency, spoke of that organization's work. The ENEA is a subsidiary of the European Organization for Economic Co-operation, formed originally to administer Marshall Plan Aid, and comprises the six Euratom countries plus Great Britain, Denmark, Norway, Sweden, Ireland, Portugal, Austria, Switzerland, Iceland, Turkey, and Greece.

ENEA has fostered several international research projects: (*a*) Dragon, a $40-million, 10-mw, high-temperature, gas-cooled research reactor to be constructed in England with costs shared by the U. K., Euratom, and five other European countries; (*b*) Eurochemic, a $20-million, small-scale plant for the chemical processing of about 100 tons a year of natural or slighty enriched uranium, and for other research; (*c*) Halden, a $4-million, international, co-operative research project on the boiling-heavy-water-reactor type. The agency also has co-ordination and stimulation functions for other international nuclear projects.

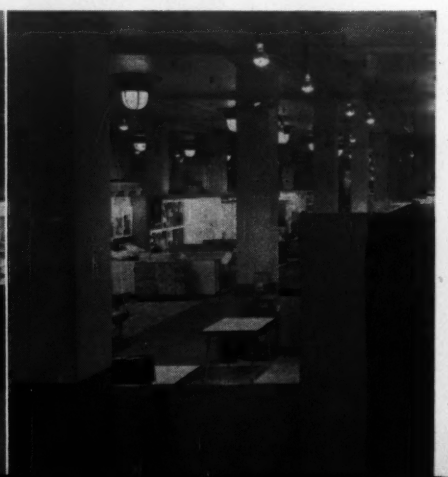
### The All-Congress Banquet

John R. Dunning, Mem. ASME, chairman of the Nuclear Congress Policy Board and dean of engineering at Columbia University, was toastmaster at the All-Congress Banquet.

"Nuclear Energy and Space" was the topic of the Banquet Address by Herbert F. York, director of research and engineering, United States Department of Defense. The address dealt with the implications of the Argus experiment for controlled thermonuclear research.

The Argus experiment was a continuation of the theoretical investigation of the belt of natural radiation which Explorer I and III satellites established as much more intense than anticipated. The object was to determine if artificial radiation, produced by an explosion in the belt region, could be measured and observed against the background of natural radiation magnetically trapped in space by the earth's field.

It has since been learned that, for reasons still not understood, there are two belts of high-intensity radiation, not one. The detonation happily took place in the valley between them, making measurement easier and more positive.



The significance for thermonuclear research lies in the fact that the confinement produced by the earth's magnetic field resembles, on a large scale, the magnetic Mirror Machine which is being used in experiments at the University of California Radiation Laboratory in Livermore, Calif. The Argus experiment demonstrated that there was no diffusion of electrons transverse to the field, an important point which had not been determined in the UCRL experiments.

Dr. York stated that other points of general interest determined by the experiments were a better understanding of the radiation belt discovered only a year ago. Explorer IV made 250 transits of the artificial electron shell. The earth's magnetic field was measured out to 1500 miles but was believed to extend—by extrapolation—to 4000 miles.

A brilliant auroral glow was observed, giving more understanding of this phenomenon, since it was produced by a known quantity of electrons injected into the earth's atmosphere at a known time.

Dr. York emphasized that there was *no* fallout hazard for two reasons: (*a*) The yield was small—thousands of times less than that produced by other bombs; (*b*) lack of containment, since the effect of the explosion took place in a near vacuum and was spread over a large area.

## Technical Program

***U. K. and French Reactors.*** Among the high lights of the technical sessions were papers on the European gas-cooled graphite-moderated reactors. A group of five papers (140–144)[1] described the most important features of the G2 and G3 reactors built at the Atomic Energy Center at Marcoule, France. These natural-uranium reactors have a number of unusual features. Biological shielding and pressure vessel are combined in a unique horizontal cylinder of cable-reinforced prestressed concrete with 3-meter-thick walls, designed for internal-operating pressures of about 213 psig.

Each of the 1200 horizontal fuel channels is continuously loaded and can be refueled while in operation. A movable charge machine feeds fuel slugs in at the face, pushing the whole train through the reactor and ejecting it at the rear via a system of spouts, chutes, and locks into a cooling pond. The continuous loading prevents the disturbance of reactivity distribution.

British emphasis in gas-cooled reactor development, described in papers on the Hunterston (63) and Berkeley (64) stations now under construction, is in the direction of greater efficiency and economically competitive power generation. Simplicity of construction and, where necessary, deliberate sacrifice of over-all thermal efficiency are regarded as the keys to capital-cost reduction since fuel charges represent only 30 per cent of the kwhr cost. Hence the Berkeley two-reactor station has the lowest thermal efficiency and steam conditions of any of the nuclear plants now being constructed in the United Kingdom.

The two reactors at Hunterston, in the vicinity of Glasgow, Scotland, will be charged and discharged with reactor coolant at full pressure and while the station generates at full output by a machine operating beneath the pressure vessels. The main pressure vessels are of two-shell construction to permit welding on the site and to shield the outer vessels from hot gases emerging from the upper ends of the channels.

The moderator temperatures have been raised to prevent the build-up of Wigner energy in the graphite—responsible for the Windscale accident. With this modification, the reactors are expected to run for at least 50 years at 80 per cent load factor before graphite annealing is necessary. Since this temperature is higher than desirable for a gas-inlet temperature, fuel elements are sleeved in graphite.

British experience indicates that there is no reason to abandon the gas-cooled reactor, and capital-cost reduction should continue for natural or near-natural uranium reactors in the 40 to 400-emw range. Improved canning materials are expected to overcome the fuel-element-can burst rate limitation at higher working temperatures and to culminate in the introduction of a high-temperature gas-cooled design near the end of the 1960's.

***Power Reactor Design.*** A Canadian study has been made for an active-circuit 400-emw-net helium-cooled ceramic reactor that would produce steam at current conventional temperatures and pressures. Called the Daniels-Boyd Nuclear Steam Generator (54), it would produce high-quality steam at 2400 psig and 1050 F.

Another Canadian study (57) would overcome the high capital charges for heavy water where it is used both as moderator and coolant by using a combination of organic coolant and heavy-water moderation. Net thermal efficiency for the 150-mw plant would be 31.4 per cent and power costs are estimated at 4.95 to 9.7 mills per kwhr depending on load factor and capital-charge rate.

A paper on the design of a 10-emw sodium-deuterium reactor (56) was also presented.

The evolution of the U. S. Army Package Power Reactor (55) was described since larger nuclear plants are expected to follow a similar evolution over a much longer time scale. Although conceptual design began only in 1953-1954, two reactors of the APPR type are already in operation, and a third is in the design stage. Fuel-element and control-rod types are considered proved. There have been important modifications in the pressure-vessel design, neutron-source and photoneutron-block arrangements, and other primary-system components.

Others include local flux suppressors and shielding for the bottom control-rod-drive area.

***Reactor Operating Experience and Maintenance.*** The APPR has also been the subject of a study on the mechanism of long-lived-radioactivity build-up (118). While data obtained to date are inconclusive, the difference in the corrosion rate of materials may be the major factor contributing to the variations in ac-

[1] Numbers in parentheses designate ASME papers available in preprint form from Engineers Joint Council, 29 West 39th Street, New York 18, N. Y., and shown by author and title in the Availability List on p. 118.

tivity-build-up rates on different materials in contact with coolant.

Both the mechanism and the rate of corrosion were determined for a stainless steel tab in flowing sodium at 1575 F (114). This decays by a factor of three from the 500-hr rate to an apparently constant value of 0.5 mg per sq cm a month at 4000 hr. The decay is due to formation of a ferritic layer on the tab rather than to changes in the sodium.

Construction scheduling for the 180,000-ekw Dresden Nuclear Power Station required close co-ordination of all delivery dates and construction steps (134). The pressure vessel and containment sphere were the major long-term-delivery items in the $2^1/_2$-yr over-all construction timing, and most of the enclosed equipment had to be delivered before concrete was poured. The installation of instrumentation was also complex. Construction, which began March 1, 1957, is on schedule and was two thirds complete this February.

An unusual technique described was the use of ice "valves" in the Homogeneous Reactor Experiment, HRE-2, to effect positive cutoff of flow in the process lines. Refrigeration creates ice plugs to augment valves that are prone to leak, or to prevent the escape of reactivity from piping and the entry of water during disassembly under shielding water. Refrigeration also is used on off-gas lines to recover heavy water and prevent moisture from reducing the effectiveness of charcoal adsorber beds. Remote maintenance experience with the HRE-2 was also described (120).

There were two papers on stress analysis. One derived formulas for the exact temperature distribution, and the exact axial, radial, tangential, and shear stresses in hollow cylinders from asymmetrical heat generation (31). The other developed simple approximate formulas for the determination of stresses resulting from internal pressure at the junction between a support skirt and the pressure vessel (28).

***Fuel-Element Fabrication.*** Experiments by the American supplier with a number of fuel-element configurations determined that concentric tube assemblies made of brazed plates and riveted and deformation-locked assemblies would be most economical for the Belgian Test Reactor (85).

***Training Reactor.*** The University of Florida training reactor was described (10). It is of the same general type as the Argonaut, but has added shielding.

The 1960 Nuclear Congress will be held at the Coliseum and Hotel Statler Hilton, New York, N. Y., April 3–8.

## Nuclear Congress Papers and Proceedings—1959 Availability List

PAPERS for the 1959 Nuclear Engineering and Science Conference are available at 50 cents each from Engineers Joint Council, 29 West 39th Street, New York 18, N. Y. Also available from EJC are the papers presented at the Seventh Hot Laboratories and Equipment Conference, in bound sets, at $10 a set.

**V—1** Evaluation of the Initial Performance of the Shippingport Radioactive Waste Disposal Plant, by J. R. Lapointe, W. J. Hahn, and E. D. Harward

**V—2** Development of Design Principle for Disposal of Reactor Fuel Waste Into Underground Salt Cavity, by Shosei Serata and E. F. Gloyna

**V—3** Proportional Sampling of Flowing Liquid Wastes for Radioactivity Monitoring, by J. M. Ruddy

**V—4** Thermal Considerations in the Storage of Radioactive Wastes in Salt Formations, by R. S. Schecter and E. F. Gloyna

**V—5** Disposal of Radioactive Liquids from Nuclear Powered Ships, by J. M. Smith, Jr.

**V—6** The Need for Biological Monitoring of Radioactive Waste Streams, by R. F. Foster

**V—7** Radiological Health Training for Personnel Responsible for Water Quality, by D. W. Moeller, D. A. Pecsok, and H. P. Kramer

**V—10** The University of Florida Training Reactor, by J. M. Duncan

**V—11** The Army Training Program for Nuclear Power Plant Personnel, by W. Eager, D. King, and J. LaFleur

**V—13** Instrumentation for Experimental Reactor Kinetic Studies, by E. L. Gardner

**V—14** Critical Experiment Safety Systems With Electrometer-Type Operational Amplifiers, by Russell Ball

**V—15** Simulation of the EBWR for the Geneva Conference, by R. N. Brey, Jr., J. W. Schwartzenberg, V. S. Underkoffler, and J. M. Finan

**V—17** Approximate Solutions to the Reactor Kinetic Equations for Ramp Inputs, by John MacPhee

**V—18** A Low-Cost Nuclear Power-Plant Simulator, by C. Scott and E. B. Dahlin

**V—19** Some Considerations in the Development of Emergency Procedures in Case of an Accidental Release of Liquid Radioactive Wastes From a Nuclear Reactor, by E. D. Harward

**V—21** Assembly and Operation of Low-Level Counting Facility, by G. R. Hagee, B. Branson, A. S. Goldin, G. J. Karches, and C. P. Straub

**V—22** Radioactivity in Water—Environmental Surveillance, by H. P. Kramer, D. W. Moeller, and D. A. Pecsok

**V—23** Design and Development of a 600 F Pulse Preamplifier for Nuclear Instrumentation, by W. L. Frisby and F. M. Palmer

**V—24** A Dual-Channel Reactor Protection System for Nuclear Power Plants, by A. S. Bartu

**V—25** Transfer-Function Response of a High-Impedance Nuclear Power Channel, by R. J. Allen

**V—26** Circuits in the MTR Pulse Analyzers, by Frank Petree

**V—27** Halogen Tube Remote Area Monitoring System, by H. A. Brown and J. V. Rogers

**V—28** Stress Analysis of the Junction Between a Support Skirt and Pressure Vessel, by R. F. Wojcieszak

**V—30** Cold Traps, Freeze Jackets, and Refrigeration System Used in the HRE-2, by R. C. Robertson

**V—31** Stresses in Hollow Cylinders Due to Asymmetrical Heat Generation, by H. Kraus and G. Sonnemann

**V—32** Some Aspects of Safeguarding High-Pressure Systems in Nuclear Technology, by R. N. Scott

**V—33** Radiation and Contamination Control at the Hanford Reactors, by S. L. Nelson

**V—34** Alteration of a Gamma Cell for Plutonium—Gamma Usage, by H. M. Glen

**V—35** Bases for Establishing Nuclear Safety Criteria, by Norman Ketzlach

**V—37** The Validity of Film Badge and Pocket Chamber Records in Evaluating the Radiation Exposure of Personnel, by Hanson Blatz

**V—40** Determination of Local Heat-Transfer

A Nuclear Science program preceded the opening of the AtomFair

Coefficients by a Transient Technique, by J. B. Conway and R. A. Stanley

V—41 The Graetz-Nusselt Problems (With Extension) for a Bingham Plastic, by E. H. Wissler and R. S. Schechter

V—42 Design Selection Technique Applied to Astro-Heat Exchange, by J. R. Boyd

V—44 A Transistorized Power Reactor Safety System, by H. H. Hendon

V—45 A Digital Start-Up Control for Mobile Nuclear Reactors, by S. N. Lehr and Vernon Mathis

V—46 Magnetic Automatic Power-Range Control for an Aircraft Nuclear Reactor, by S. F. Hemmenway, J. A Russell, J. L. Scharf, and P. C. Sharr

V—47 Electrical Control System Components for Starting Aircraft Propulsion Reactors, by R H. Willsey, P. K. Hiser, M. E. Ward, and A. D. Wilcox

V—48 Development Studies on the Solidification of Radioactive Waste by Fluid-Bed Calcination, by J. W. Loeding, E. L. Carls, and A. A. Jonke

V—49 Radiochemical Reprocessing Costs in an Expanding Nuclear Economy, by C. E. Guthrie

V—50 Review of Developments in Reprocessing of Irradiated Nuclear Fuels by Pyrometallurgical Methods, by L. F. Coleman, J. H. Schraidt, and C. J. Bernstein

V—52 Production of Pure Uranium Hexafluoride From Ore Concentrates, by W. C. Ruch, D. A. Peterson, E. A. Gaskill, and H. G. Tepp

V—53 Investigation of Chemical Methods for Nuclear Reactor Decontamination, by J. L. Zegger and G. P. Pancer

V—54 The Design of a Daniels-Boyd Nuclear Steam Generator for a 400 MW (Net E) Power Plant, by W. Boyd, J. A. Paget, and Paul Hamel

V—55 Evolution of the Army Package Power Reactor Family, by J. G. Gallagher

V—56 Design of a 10-Emw Sodium Deuterium Reactor Power Plant, E. D. Oppenheimer, J. G. Duffy, and C. Graves

V—57 The Potential of Organic-Cooled Heavy-Water Reactors for Economic Power Generation, by M. J. McNelly

V—58 Effects of Reactor Exposure on Boron-Lined and $BF_3$ Proportional Counters, by W. M. Trenholme

V—60 A Differential Pressure Instrument for High-Temperature Service, by S. A. Hluchan

V—61 Clamp-on Resistance Temperature Detectors for Reactor Use, by R. G. Clark

V—62 Acceptance Testing of Nuclear Power Plants, by W. H. Hamilton and G. H. Conley

V—63 The Hunterston Project and the Future Development of the Gas-Cooled Power Reactor, by K. J. Wootton

V—64 The Berkeley Nuclear Power Station and Its Influence on Future Developments, by A. L. Shaw

V—66 Nuclear Power Development in Italy, by N. B. Cacciapuoti

V—71 Design vs. Performance of Process and Equipment in a Large-Scale Radiochemical Separation Plant, by A. W. Joyce, E. B. Sheldon, and L. C. Peery

V—72 Design and Operating Considerations for Off-Gas Systems in Nuclear Processing, by L. R. Michels

V—74 Comparison of Design and Operating Performance at the Idaho Chemical Processing Plant, by A. L. Ayers and F. M. Warzel

V—75 Measurement of Gear Wear by Activating Wear Particles in the Lubricant, by H. D. Briggs and John Coultry

V—76 Radioisotope Utilization in Industrial Applications, by Paul Kruger

V—77 Radiochemical Tracing of Pilot Unit Fluid Catalyst Flow, by Annelle von Rosenberg and R. L. Hull

V—78 An Investigation of Sodium Phosphate Hide-Out in Boiling Water Using Phosphorus 32, by J. W. Stout, Jr.

V—79 Radiotracer Study of Flow Patterns in a Fluid Coker, by J. M. Ausman, A. Beerbower, and R. E. Olsen

V—80 Status of Research and Test Reactors, by L. E. Link

V—81 Nuclear Calculation for a Continuously Fueled Pebble Bed Reactor, by R. O. Bagley, Jr.

V—82 AEC Reactor Physics Program, by W. C. Bartels

V—84 Neutron Energy Spectrum Calculations in Reactor Shields, by J. W. Haffner

V—85 Fabrication of BR-2 Fuel Elements, by A. Strasser

V—86 Nondestructive Clad Thickness Measurement on Uranium Oxide Fuel Pins, by R. M. Ball

V—89 Rate of Alloying of Metal Fuels With Stainless Steel Above 1500 F, by R. S. Neymark

V—90 Irradiation of Fuel Elements Containing $UO_2$ Powder, by J. L. Bates

V—91 Measurement and Control of Saran-Film Thickness, Using Beta Ray Gage, by G. C. Wiggins

V—92 Control of Fat Centrifuge by Gamma Ray Measurement, by F. Brown

V—94 Operating Experience With Instruments Using Radioisotopes in the Process Industries, by R. C. Kimball

V—95 Measurement of Liquid Density Using a Beta Ray Source, by E. J. Freeh and Charles Kearns

V—96 Continuous Analysis by X-Ray Absorption, by Alan Beerbower

V—100 The Design and Operation of a Shunt Regulated 25,000 Joule Inductive Energy Storage System, by R. L. Gamblin

V—101 The Fabrication of Tubular Uranium Fuel Elements, by C. E. Polson, H. Davis, J. F. MacNeill, J. F. Schiltz, E. S. Noe, and J. Magoun

V—102 Fabrication of Graphite-Urania Fuel for a Transient Reactor Test, by J. H. Handwerk, F. D. McCuaig, and C. H. Bean

V—103 Tensile Creep of Pure and Uranium-Loaded Graphites, by L. Green, Jr., M L. Stehsel, and C. E. Waller

V—104 Bonding of Various Metals and Alloys by Isostatic Pressing at Elevated Temperatures, by J. Fugardi and J. L. Zambrow

V—105 Segregation in Aluminum-13 Per Cent Uranium Castings, by D. Peckner

V—106 The Swelling of Irradiated U-Zr Alloy During Temperature Transients, by W. V. Johnston

V—107 The Effect of Metallic Impurities on the Properties of Uranium and 2 w/o Molybdenum-Uranium Alloys, by J. M. Dickinson and E. E. Zukas

V—108 Sinterability of $UO_2$ Powders for Fuel Elements, by R. B. Wrinkle

V—109 A Diffusion Mechanism of the Initial Sintering of Refractory Materials, by R. Chang

V—110 Forge Rolling Zircaloy Components, by R. D. Johnson, R. J. Gridley, and R. L. Clark

V—111 Irradiation-Induced Hydrogen Absorption by Nickel-Enriched Zircaloy-2, by W. Yeniscavich, R. A. Wolfe, and R. M. Lieberman

V—112 The Use of Ultrasonics in the Testing of Irradiated Fuel Elements, by J. M. Fouts

V—113 The Development of Nuclear Radiation Resistant Fluids and Lubricants, by W. L. R. Rice and D. A. Kirk

V—114 Sodium Corrosion as a Function of Time, by J. M. McKee

V—122 Concepts in Determining the Potability of Water Following a Nuclear Attack, by Gerhard Klein

V—124 An Automatic Device for Power Mapping in Heterogeneous Reactor Cores, by J. H. Mortenson and R. M. Ball

V—125 Transients in Logarithmic Count-Rate and Period Meters, by B. B. Barrow and Robert Maitland

V—126 A High Speed Micro-Current Amplifier, by J. A. Dever and Louis Sickles

V—127 An Electric Dissolved Hydrogen Analyzer by E. R. Hill and D. C. Griffith

V—129 Design Studies of Capsules for High-Temperature Irradiation, by J. H. Stang, W. H. Goldthwaite, and B. W. Dunnington

V—130 Efficiency of Some Biased-Sampling Schemes in Monte Carlo Calculations, by J. F. Perkins and M. O. Burrell

V—131 Operating Experience With Critical Experimental Reactor, by M. A. Dewar and T. E. Free

V—132 Design and Performance Characteristics of SNAP-III-B, by M. K. Barmat

V—133 Radiation Effects Reactor, by W. T. Scarborough

V—140 Part A—Core, Shielding, and Pressure Vessels, by G. Delenze and M. Tourasse

V—141 Part B—On Load Refueling, by A. Ertaud and A. Pages

V—142 Part C—Reactor Cooling, by J. C. Chaboseau and P. J. Laferriere

V—143 Part D—$CO_2$ Supply and Processing, by J. L. Hainzelin

V—144 Part E—Reactor Control, by M. Lignieres and J. Bobigeat

## MEETINGS OF OTHER SOCIETIES

**June 15–17**

American Nuclear Society, annual meeting, Gatlinburg, Tenn.

**June 15–19**

American Society for Engineering Education, annual meeting, Carnegie Institute of Technology and University of Pittsburgh, Pittsburgh, Pa.

**June 15–20**

UNESCO, international conference on information processing, Paris, France.

**June 15–20**

International Congress on Combustion Engines, Wiesbaden, Germany.

**June 16–19**

Institute of the Aeronautical Sciences, national summer meeting, Hotel Ambassador, Los Angeles, Calif.

**June 17–20**

National Society of Professional Engineers and New York State Society of Professional Engineers, annual convention and engineering progress exposition, Hotel Commodore, New York, N. Y.

**June 21–26**

American Society for Testing Materials, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

**June 22–24**

American Society of Heating Refrigerating and Air-Conditioning Engineers, annual meeting, Lake Placid Club, Lake Placid, N. Y.

**June 24–26**

Instrument Society of America, nuclear instrumentation symposium, Idaho Falls, Idaho.

**June 25–July 5**

International Federation of Automatic Control, international congress, Moscow, USSR.

**June 28–July 4**

International Institute of Welding, annual assembly, Opatija, Yugoslavia.

**June 29–July 3**

Forest Products Research Society, national meeting, St. Francis Hotel, San Francisco, Calif.

**July 13–17**

National Association of Power Engineers, National convention, Statler Hotel, Boston, Mass.

(*ASME Coming Events, see page 143*)

Dr. H. J. White (*left*) tells air-pollution control seminar that efficient gas-cleaning methods are urgently needed by industry

# Gas-Cleaning Research and Development Discussed at Air Pollution Control Seminar

High efficiency removal of suspended particles from gases is one of the basic scientific and technical problems of the modern industrial era. So said Dr. Harry J. White, director, Research and Development, Research-Cottrell, Inc., Bound Brook, N. J. He spoke at the recent Seminar on Air Pollution Control and Industrial Gas Cleaning for Technical Editors, sponsored by Research-Cottrell, Inc., and held in The Engineers' Club, New York, N. Y.

Growth of large-scale industrial operations which require, for example, the processing of huge quantities of minerals and ores as in the smelting and metallurgical industries, or the combustion of hundreds of megatons of coal per year for electric power production, he said, have given rise in the United States alone to an estimated annual emission of 50 to 100 million tons of smoke, dust, and fume. Control of these emissions by effective gas-cleaning process is essential to prevent heavy, and sometimes devastating, air pollution, and in some instances to recover valuable materials such as copper, lead, and zinc which otherwise would be carried up the stack and lost by dispersion into the atmosphere.

Dr. White pointed out that gas-cleaning methods to meet these requirements were not developed originally from planned, orderly research programs, but rather from individual efforts at the local plant level, usually in response to community and legal pressures for air-pollution control.

## Mechanical and Electrical Processes

He classified gas-cleaning processes broadly as mechanical and electrical. Mechanical processes include all of those which depend fundamentally on inertial or mechanical forces; viz., centrifugal or cyclonic separation, washing or scrubbing, filtration through screens, fabric bags or packed beds, and sonic agglomeration. The electrical precipitation process differs basically from all mechanical methods in that the separation forces acting on the suspended particles are electrostatic in nature.

Of all these processes, Dr. White said, electrical precipitation is the most versatile and the most widely used for the large-scale cleaning of industrial process and furnace gases. It is estimated that there are at present in the United States alone over 3000 electrical precipitator installations (of which some 2000 were built by Research-Cottrell) cleaning a total of about 300 million cfm of gas, and collecting approximately 15 million tons of dust, smoke, and fumes annually. Indications are that electrical precipitation applications will continue to increase sharply with the increasing demands for air-pollution control and high-efficiency cleaning of industrial gases. For example, in the electric power industry, the installed precipitator capacity for removal of fly ash from the combustion of pulverized coal may be expected to double in the next ten years, rising from the present figure of about 165 million cfm to over 300 million cfm by 1969.

## Fundamental Research

According to Dr. White, fundamental research in electrical precipitation is concerned primarily with the several critical factors which determine or limit performance. Broadly stated, high performance requires (*a*) highest possible deposition rate of suspended particles from the moving gas stream onto a collecting surface or electrode; (*b*) retention of the particle deposits on the collecting surfaces under aerodynamic stresses; and (*c*) transfer of the accumulated deposits to a hopper or other receiver, without appreciable loss or re-entrainment of particles.

Although much has been accomplished both in fundamental and applied research on electrical precipitation, much remains ahead of us, Dr. White noted. The most important areas for further investigation and development include:

1 Development of precipitators for heavy industrial applications, which will operate at much higher gas-treatment velocities. For example, in the fly-ash field it is becoming more and more essential to increase gas velocities both in order to reduce costs and to conserve space requirements for the gas-cleaning equipment in power plants. Present average velocities for fly-ash precipitators are about 7 fps. Our goal is to double this value during the next five years. Substantial progress on high gas-velocity precipitators has been made in the laboratory within the past several years. We have developed precipitators which remove oil mist of 0.7 micron

diam from air at a gas velocity of 25 fps and an efficiency of 99.9 per cent. Successful results have also been obtained at gas velocities up to 100 fps, where efficiencies of 90 per cent on the same type of oil mist have been achieved.

2 Development of more effective methods and equipment for overcoming the adverse effects of high resistivity. The resistivity problem is as old as electrical precipitation itself and many approaches have been devised to alleviate or overcome this problem. However, none of these is completely adequate and we are now in the process of developing newer concepts and principles for solving this basic problem.

3 Particle re-entrainment. This is one of the fundamental limiting factors in the dry collection of particles, and to a large extent is responsible for the present treatment of gas-velocity limitation of 5 to 10 fps. Considerable progress has been made during the past year in basic research on this important phenomenon, with the emphasis on the nature and magnitude of the forces which bind particles together and to the electrodes. Contributing research on gas flow, corona, and electrode design is also in progress to reduce particle re-entrainment.

### Other Gas-Cleaning Methods

In addition to our major field of electrical precipitation, Dr. White said, we initiated research and development programs several years ago on other gas-cleaning methods. The development of the Cyclo-trell mechanical collector is one of the results of this work. Although cyclonic dust collectors are old, we were able through the application of the fundamental principle of recovering kinetic energy from the spinning gas stream to substantially increase both the gas-flow capacity and collection efficiency. In the field of scrubbers or washers we are now in the process of developing the so-called "flooded-disk scrubber." Again, scrubbers have been used for many years in gas cleaning, but we have been able to introduce better principles for dispersing the scrubbing liquid and insuring intimate contact with the suspended dust particles.

## Graphite Now Produced in Flexible Textile Form—Applications "Limitless"

MANUFACTURED graphite, refractory work horse in scores of industrial and military applications, is now being produced in flexible fiber and fabric form. National Carbon Company, Division of Union Carbide Corporation, has developed a revolutionary process to convert organic textile forms directly to graphite with a purity in excess of 99.9 per cent.

Any textile form—yarns, braids, and felts, or fabrics that are woven or knit—can be produced in this unique material. In the complex production process, for which patents have been applied, a fiber or fabric such as rayon is graphitized by electrically heating it to a temperature approaching 5400 F. In this thermochemical conversion, the crystalline structure of the material is changed to that of graphite similar to manufactured graphite used for electric furnace electrodes, nuclear reactor structures, metallurgical molds, or in any other of graphite's myriad industrial uses.

***Graphite Has No Melting Point.*** Graphite's unique combination of electrical, chemical, and mechanical properties—coupled with the wide variety of textile forms now available—gives promise of significant applications of the new material in almost every segment of industry. At ordinary pressures, graphite has no melting point, and sublimes (goes directly from solid to vapor state) only at extremely high temperatures (approximately 6600 F). Graphite has the unusual property of getting stronger at higher temperatures, and its tensile strength at 4500 F is about twice that at room temperature. Graphite oxidizes in air at temperatures in excess of 750 F. At the low end of the temperature scale, the known properties of graphite fabrics are unaffected by liquid nitrogen at a temperature of −320 degrees F.

Graphite textiles are resistant to attack by acids, alkalies, and organic compounds, except for those of a highly oxidizing nature, and are unreactive with many molten metals. They have excellent electrical and thermal conductivity, and being in flexible form, are immune to thermal shock. Graphite also has well-known lubricating properties that extend its high-temperature applications even further.

***Possible Uses Are Legion.*** The combination of properties and available forms makes applications of graphite textile forms almost as limitless as equipment designers' ingenuity. One field in which experimental quantities of graphite cloth are being evaluated is as a reinforcing agent for various plastics and refractory materials used at high temperatures, such as in the nose cone of space missiles. Plastic and refractory materials subject to thermal cycling are also an excellent potential use for graphite cloth.

Graphite fibers and fabrics can be used to impart electrical and thermal conductivity to nonconducting materials such as plastics, ceramics, and even to other textile materials such as glass cloth.

Possible mechanical applications combine thermal properties with self-lubricity, and include valve packing and gasket materials for high-temperature seals such as those in jet engines. Conveyer belting for high-temperature process equipment is another possibility. A matt form of the material could be used as thermal and/or acoustical insulation.

**Graphite fibers and fabrics can be produced in the same wide range of textures as are available in conventional textile forms. Shown are but four of the various weaves of graphite cloth being experimentally produced.**

## Flight Safety Help

### *Easy-to-Read Altimeter Introduced by Bulova*

A NEW type of aircraft altimeter, said to cut reading time and eliminate reading errors, was demonstrated at a press conference in New York City by the Bulova Watch Company, the developer of the device.

General of the Army Omar N. Bradley, chairman of the board, told that the U. S. Air Force has ordered a test quantity of 25 Bulova altimeters for extensive laboratory testing and flight evaluation in many types of Air Force planes.

General Bradley said, the altimeter is "extremely accurate and highly sensitive, reacting instantaneously to changes in altitude even in very rapid ascent or descent and thus providing improvement in the safety factor of aircraft operation."

Tests have shown the altimeter indicates altitude with an error of less than ten ft at sea level, General Bradley said. Tests made by a major aircraft company showed a deviation (plus or minus) of 20 ft for the new altimeter at 12,000 ft, as compared with a 200-ft deviation for a conventional altimeter on the same evaluation. Its sensitivity, he said, is such that raising or lowering the instrument as little as two ft gives a visible indication on the scale when one is at or near sea level.

Everett M. Patterson, president of the Bulova Research and Development Laboratories, Inc., explained that altitude readings are shown on a continuous logarithmic tape. The new Bulova Altimeter eliminates the use of moving pointers. It uses a tape, about 40 ft long, ranges from −1000 ft to +65,000 ft, and is driven vertically past a window in the instrument by a servo motor. "It follows the true altitude without fluctuation or 'hunting'," Patterson said.

At sea level the numbered graduations are separated a full in. for each 50 ft of altitude. At 20,000 ft the numbered graduations mark each 100 ft; at 40,000 ft the graduations stand for 200-ft increments, and from 60,000 ft up the increments are of 500 ft each. (There are smaller, unnumbered graduations dividing each of the major segments throughout the tape.) This tape presentation supplies greatest readability and accuracy where most needed—at lower elevations and landing altitudes.

Patterson said the altimeter's sensing elements are Melchior type aneroid capsules, and that Bulova manufactures these itself "to achieve consistently reliable performance."

The output of the sensing elements is transferred to the indicating mechanism electrically, freeing the sensing elements of all mechanical work, eliminating friction, and producing a sensitivity previously unknown, Patterson said. It also "obviates the need for vibrational stimulation of the instrument," he added. (There have been cases where faulty functioning of an altimeter was attributed to "stickiness" due to the "too smooth" flight of a jet plane.)

The new instrument is the product, Patterson said, of a company-sponsored four-year altimetry project conducted at the Bulova Research and Development Laboratories in Woodside, N. Y. Production, he told, will be carried on by the industrial and defense division of the Bulova Watch Company at Jackson Heights, N. Y.

**Easy-to-read altimeter demonstrated by Gen. Omar N. Bradley, board chairman of the Bulova Watch Company, cuts reading time and reading errors. Altitude is shown on tape instead of dial. The new instrument—the product of a four-year project conducted by the Bulova Research and Development Laboratories — is extremely accurate and highly sensitive.**

## W. F. Durand Centennial Conference

A CONFERENCE on the problems of hypersonic and space flight will be held at Stanford University, Stanford, Calif. Aug. 5–7, 1959. The meeting will be held in honor of the 100th anniversary of the birth of William Frederick Durand, pioneer aeronautical engineer, who died last summer at the age of 99. Dr. Durand served as President of The American Society of Mechanical Engineers, 1924–1925.

The meeting will be sponsored by the Air Force Office of Scientific Research, the Office of Naval Research, the Office of Ordnance Research, and the National Science Foundation. The speakers include: H. Julian Allen, Ames Research Center, NASA; Luigi Broglio, Mem. ASME, University of Rome, Italy; Johannes M. Burgers, University of Maryland; Francis Clauser, The Johns Hopkins University; Hugh L. Dryden, Fellow ASME, National Aeronautics and Space Administration; Wilfred H. Dukes, Bell Aircraft Corporation; Antonio Ferri, Polytechnic Institute of Brooklyn; Richard R. Heldenfels, Langley Research Center, NASA; Wolfgang B. Klemperer, Douglas Aircraft Company, Inc.; Leslie S. G. Kovásznay, The Johns Hopkins University; Hans W. Liepmann, California Institute of Technology; Gordon N. Patterson, University of Toronto, Canada; Sir Geoffrey Taylor, Cambridge University, England; R. H. Thielemann, Deutsche Versuchsanstalt für Luftfahrt, E. V. Germany.

Dr. Durand was professor of mechanical engineering at Stanford University from 1904 until 1924. After his retirement he edited the six-volume work entitled "Aerodynamic Theory," which is still one of the important source works of information on aerodynamics. During World War II, when he was in the middle 80's, he was active in Washington in organizing research and development in jet propulsion. In Dr. Durand's honor, the Aeroscience Laboratory of Stanford University will be renamed the Durand Laboratory during the conference.

Attendance at the conference is not restricted. There will be a registration fee of $3 per person. Room and board will be available on the Stanford Campus for those who make arrangements in advance. The papers presented at the conference will be published in a volume of Proceedings. Further information may be obtained from Dr. Nicholas J. Hoff, Head of the Division of Aeronautical Engineering, Stanford University, Stanford, Calif.

## Two Research Reactors Operational at Columbia

COLUMBIA UNIVERSITY, which 20 years ago conducted the nation's first experiments in atomic fission, has expanded its nuclear program to teach young engineers how to find practical uses for this enormous energy source, John R. Dunning, Mem. ASME, dean of the School of Engineering, announced.

The University placed the second of two "subcritical" atomic reactors in operation on the Morningside Heights campus early in April.

Dean Dunning, a pioneer in the nuclear energy field, said the two reactors—both uniquely designed for experimental purposes—make the University's new Nuclear Science and Engineering Program fully operational.

The Dean said the program, directed by Prof. Thomas B. Drew, is designed to train a "new and scarce breed" of engineers called nuclear engineers. These men, he said, combine engineering skills with a knowledge of nuclear science to solve countless problems in industry, agriculture, and medicine.

Dr. Dunning, who, as an associate professor at Columbia, conducted the first U. S. demonstration of nuclear fission early in 1939, said there is an acute shortage of nuclear engineers.

The shortage is so severe, he said, that the Atomic Energy Commission is providing colleges and universities with funds to purchase equipment to train engineers who can put nuclear discoveries into use.

Columbia has been awarded two AEC grants totaling nearly $76,000. The money was used to build the two reactors—a graphite reactor pile and a water-moderated system—and to purchase basic nuclear-engineering equipment which will be used for counting radioactive particles and for measuring properties of nuclear materials.

In the graphite reactor, 120 aluminum tubes containing 25 lb of uranium each, are inserted in the five-ft-square, six-ft-high cubicle-shaped pile of graphite blocks. In the water system, up to 300 tubes are suspended in a tank of water six ft high and four ft in diam. Graphite and water serve to moderate or slow down nuclear fission, thereby helping the reactors to work more effectively.

In conventional nuclear reactors, the chain-reaction rate is controlled at a level just sufficient to keep it going. The Columbia reactors never achieve this "chain reaction." They both function at the subcritical level where an amount of uranium just under the amount necessary for a chain reaction is inserted into the reactors. Dr. Dunning said this system is best for educational purposes and results in maximum safety.

Dean Dunning praised the flexible design of the two reactors and said he believed they were the only two such reactors in the country.

The graphite pile is surrounded by wooden panels. One side of each of the panels is covered with boron-impregnated paraffin. When the impregnated paraffin faces in toward the pile, the students can observe what happens as the boron absorbs the speeding neutrons.

In a matter of minutes, the shields can be reversed, allowing the students to observe the actions of neutrons under opposite conditions.

The reactors were designed by Dr. Edward F. Leonard, an assistant professor of chemical engineering, who is in charge of the laboratory portion of the new program. Dr. Erwin H. Amick, Jr., is chairman of the Chemical Engineering Department.

**Edward F. Leonard, assistant professor of chemical engineering, Columbia University, places uranium elements into graphite pile. Reactor is used on the Morningside Heights campus in the new Nuclear Engineering Program. Dr. Leonard designed the pile.**

The graphite pile was assembled on the campus. The water-moderated unit was built by the Universal Nuclear Corporation of Jamaica, Long Island, N. Y.

## Three New ECPD Brochures to Guide Young Engineers

THREE new brochures to guide young engineers during their first few years after graduation have been announced by the Training Committee of the Engineers' Council for Professional Development.

This new literature is published in support of the First Five Years program of ECPD. It is designed to assist the young engineer in the critical early years of the postgraduate period.

*Your First Five Years*, outlines the challenge to the young graduate embarking upon an engineering career, cites several guiding principles, and suggests a six-point professional development program. Ten cents a copy.

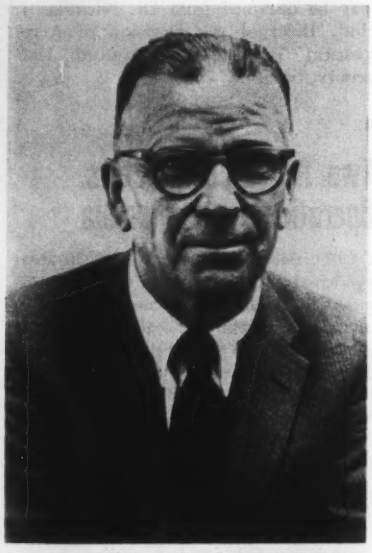
*Selected Reading for Young Engineers*, contains a recommended reading list with suggestions in the fields of biography, travel, history, economics and sociology, psychology, philosophy, natural sciences, and general literature. Fifteen cents each; quantity discount on request.

*Personal Appraisal*, Questionnaire, is designed to aid the young engineer in evaluating his progress periodically so that he may effectively plan his steps in future professional development. Ten cents each copy.

All of these new publications are available as separate items or will be furnished with each purchase of the basic reference manual, "A Professional Guide for Young Engineers." This professional guide contains "The Second Mile" papers of William E. Wickenden, and also includes a statement of the "Canons of Ethics for Engineers," and the "Faith of the Engineer." The Guide and three brochures cost $1. Write ECPD, 29 West 39th Street, New York 18, N. Y.

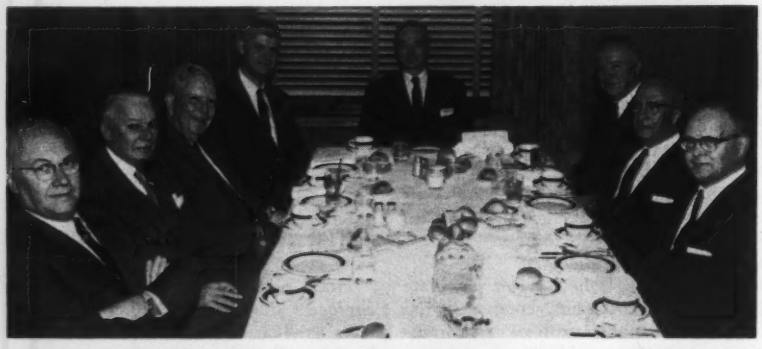
Thomas J. Dolan, Vice-President, ASME Region VI, *left,* presents charter to members of the newly formed Valparaiso University Student Section. Representing the student engineers are: *left to right,* William Raabe, Student Section chairman; James Horn, vice-chairman; and Arnold Hilgenkamp, secretary.

Mervin J. Kelly, retiring chairman and former president, Bell Telephone Laboratories, has been appointed consultant by IBM and by Bausch & Lomb. Mr. Kelly is the recipient of the year's Stevens Honor Award. He is also the recipient of the John Fritz Medal. Mr. Kelly is chairman of the Industry Gifts Committee for the United Engineering Center Fund.



## PEOPLE

Martin Company engineer tests radioisotopic "battery" which won 1958 Miniaturization Award. The 5-lb atomic generator can produce power during its lifetime equivalent to that of dry-cell batteries 300 times its weight. Award is sponsored by Miniature Precision Bearings, Inc., Keene, N. H.



Fellows of the ASME Chicago Section meet for an informal get-together. Seen here, *left to right,* F. S. G. Williams; J. D. Cunningham, past-president ASME; J. C. Witt; J. J. Kanter; T. S. McEwan; W. A. Dundas; R. D. Brizzolara; and R. F. Onsrud.

***Honors and Awards.*** DETLEV W. BRONK, Hon. Mem. ASME, president, National Academy of Sciences, is the recipient of the first honorary degree conferred by the University of California on its La Jolla campus.

JAMES R. KILLIAN, JR., President Eisenhower's first Special Assistant for Science and Technology Research, has received the 1959 Washington Award "for exceptional leadership and achievement in scientific and technological education and distinguished service to his country and mankind." The Washington Award is the highest national honor given to an engineer by his fellows. It is conferred on the recommendation of a commission representing the ASCE, AIEE, AIME, ASME, and the Western Society of Engineers.

JOHN R. DUNNING, Mem. ASME, dean of the Columbia University School of Engineering, who has played a key role in the development of the United States atomic energy program, has been awarded the Michael I. Pupin Anniversary Medal for "distinguished service to the nation."

ALFRED O. SCHMIDT, Mem. ASME, is the recipient of the ASTE Medal for his contributions as "an authority in the areas of machinability and thermodynamics of metals." KENNETH J. TRIGGER, Mem. ASME, received the ASTE Research Medal for his work as a "basic researcher in the fields of physical metallurgy, metal cutting and machinability of metals, and a developer of an analytical method of determining tool-chip interface temperatures." Professor Trigger was the 1957 recipient of the ASME Blackall Machine Tool and Gage Award.

FREDERICK KRUG, Mem. ASME, was designated by the Board of Governors

of the Copper Union Alumni Association as this year's recipient of its highest annual award, the Gano Dunn Medal, for outstanding professional achievement.

ROBERT A. W. CARLETON, president and founder of the Carleton Company, Inc., construction engineering firm, has been named the 1959 recipient of the Egleston Medal, Columbia University's highest award for "distinguished engineering achievement."

ROBERT H. GODDARD (1882–1945), distinguished American rocket pioneer, has been named posthumously the first recipient of the annual Louis W. Hill Space Transportation Award. The award, which carries a $5000 honorarium, was presented to the scientist's widow at the annual Honors Night Dinner of the Institute of the Aeronautical Sciences. The new award, administered by IAS, was established by the Louis W. and Maud Hill Family Foundation of Minneapolis, Minn.

***New Appointments.*** MORROUGH P. O'BRIEN, Mem. ASME, has been named a director of McGraw-Hill Publishing Company, New York, N. Y.

GLENN T. SEABORG, a member of the board of directors of Nuclear Science and Engineering Corporation, Pittsburgh, Pa., has been appointed by President Eisenhower to the President's Science Advisory Committee. The Committee advises the President on matters relating to American science and technology.

ERNST W. SPANNHAKE, Mem. ASME, has been appointed director of research and engineering of Raymond International Inc. In his newly established position, Mr. Spannhake will be responsible for design and improvement of equipment and machinery used by Raymond in its pile-driving, construction, pipelining, and manufacturing operations.

LEWIS L. STRAUSS, Secretary of Commerce, has appointed two observers to the Standards Council of the American Standards Association. They are JOHN GREEN, director of the Office of Technical Services, and A. T. MCPHERSON, associate director, National Bureau of Standards.

***Campus Data.*** GROVER LOENING, director, Flight Safety Foundation, New York Airways, and Fairchild Engine and Airplane Company, has been named the first Lester D. Gardner Lecturer by the Department of Aeronautics and Astronautics at Massachusetts Institute of Technology. The Lectures are made possible by a bequest of the late MAJOR GARDNER, Assoc. Mem. ASME, to sponsor annual lectures on the history of aeronautics.

## EDUCATION

### AEC Grant

NEW YORK University's College of Engineering has received a grant of $6240 from the Atomic Energy Commission for use in the education and training program of the College. The money will be spent for equipment to augment the subcritical nuclear reactor and the million-volt Van de Graaf "atom smasher" already installed at the College on NYU's University Heights (Bronx) campus. The new equipment, according to Dean J. R. Ragazzini, will be used by students working toward the master's degree in nuclear engineering. Nuclear engineering courses have been offered by NYU since 1950.

### Nuclear Chemistry Lab

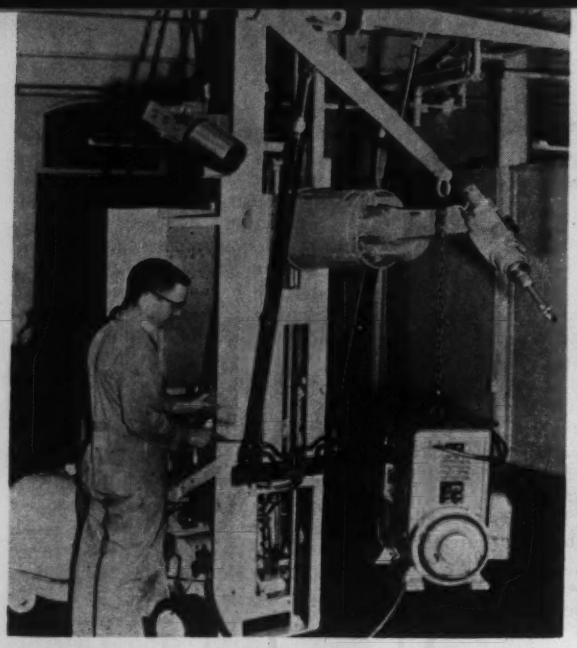
WITH the aid of a grant from the U. S. Atomic Energy Commission, The Cooper Union Engineering School inaugurated this semester a laboratory course in nuclear chemistry for second-year chemical engineering students. Working with the latest equipment, both stationary and portable, students are learning to detect and to make measurements of radiation produced by cobalt-60, carbon-14, phosphorus-32, and radium.

### New Building

THE California Institute of Technology, Pasadena, Calif., has received from the W. M. Keck Foundation and the Superior Oil Company a gift of $2½ million for the construction of a new engineering building. The new building will be located at the northwest corner of San Pasqual Street and Chester Avenue.

The proposed five-story structure, with two floors below ground, will consist of a laboratory of engineering materials, a laboratory of sanitary engineering, and a laboratory of hydraulics and water resources.

**A course designed to present patent problems and procedure, and to aid local firms toward developing new products, was offered at the Portland State Extension Center, Portland, Ore. The Oregon Section ASME was co-sponsor of the course with the U. S. Small Business Administration and Portland Extension Center. Preparing details for the course are, *seated left to right,* Dr. Milton Davis, Portland State Extension Center; and John G. Barnett, U. S. Small Business Administration. *Standing left to right,* Elmer A. Blackhorn, patent attorney; and Robert C. Portouw, chairman, ASME Oregon Section.**



A new strain of robots, with the ability to lift half a ton of dead weight or repair delicate machinery, is emerging to help man tame the atom. The Babcock & Wilcox Company's Atomic Energy Division is developing the automatons. A B & W engineer is shown, *left*, making a minor adjustment on the largest of a six-man robot "team" being developed to do maintenance and repair work in radioactive areas. *At right*, nuclear specialist uses closed circuit television to study the response of a robot tow-truck to his commands. The facility, developed for use in radioactive fields, also will contain a pipe welder, pipe cutter, 50-ton capacity crane, and mobile manipulator capable of duplicating 48 human arm and hand functions.

RESEARCH

### NSF Research Grants

THE National Science Foundation has announced the award of 56 grants totaling approximately $800,000 to 54 educational institutions for the purpose of conducting programs in Research Participation for Teacher Training in summer, 1959.

The programs are designed to provide research experience for about 550 teachers of science and mathematics from secondary schools, junior colleges, and small colleges.

Teachers will participate directly in scientific research in the laboratories of universities and colleges, or in field research programs, alongside experienced scientific investigators. The research activity will be supplemented by seminars and lectures on research methods and advances.

A scale model of the Yankee Atomic Electric nuclear power plant being built by Stone & Webster Engineering Corporation, at Rowe, Mass., is helping engineers and scientists visualize problems in the design of the plant. Charles T. Chave, Mem. ASME, *left*, and Walter C. Woodman, Mem. ASME, discuss features of the nuclear steam generator inside the 125-ft diam steel sphere. Shown on the model is one of the primary loops, with steam generator, pump and piping, and the regenerative heat exchangers for feed and bleed. Space is tight since the design calls for the lowest possible initial investment. Because of the space restrictions, the model is helping solve problems of piping flexibility, drainage, shielding, manpower access, missile protection, and accessibility of valves and equipment for maintenance in place or removal. Another use of the model that has been found invaluable is the coordination of mechanical engineering and structural design.

### Computer Control

CO-OPERATIVE effort by Daystrom, Inc., and Universal Oil Products Company has resulted in successful pilot plant application of the first computer-operated control system for continuous processing. This accomplishment resulted from several years of co-ordinated activity by Daystrom and Universal. It is expected to broaden the applications for continuous processes by controlling operations too complex for previously available systems.

A joint statement, issued by the firms, said: "The major significance of this combined effort lies in the emergence of a unique service to the entire petroleum and petrochemical industries. For the first time, refiners will have access to the advantages of electronic computer control applied to processes by companies highly skilled in the petroleum, petrochemical, and electronic fields."

## IBM 709 at UCLA

AMERICA's first university computer center specializing in complicated business management problems was dedicated Jan. 29, 1959. The $5 million Western Data Processing Center is at the University of California at Los Angeles.

A $3\frac{1}{2}$ million IBM 709, most powerful commercial electronic computer made by the firm, has been given to the university.

The computer's impressive accomplishments include the ability to make up to 2,400,000 "decisions" per minute in terms of true and false answers, memorizing over 1 million bits of information at one time, and simultaneously reading, writing, and computing.

Broad areas of the Center's research will include studies of a universal programming language to facilitate communication among different computers; of information flow within, to, and from a business system; and of the problems of a highly centralized data processing system operating in a decentralized business.

## Automation Language

LEADERS of the Air Force, science, and industry have announced the development of a mechanical-brain language. The language consisting of 107 words, will enable mechanical brains to supervise other electronic machines producing such items as airplane and missile parts. The use of the system, called Automatically Programmed Tools, will make possible better airplanes and missiles, probably at great savings. The brain can easily use the language to produce a scaled-down version or an enlarged version of any machine or tool.

The project is the joint effort of M. I. T., the Air Force, and the Aircraft Industries Association.

## Atoms in Competition

ATOMIC energy development should be placed in the hands of industry where it can be accelerated through commercial competition and "competition between the minds of men," it was proposed by Alfred Iddles during the keynote address which opened the Cincinnati Council on World Affair's Fifth Annual Conference on International Affairs, held at the Sheraton-Gibson Hotel, Cincinnati, Ohio, January 30.

Mr. Iddles, Fellow ASME, former president of the Atomic Industrial Forum and retired president and currently a director of The Babcock & Wilcox Company, said that more rapid advancement of economic nuclear power will benefit the United States abroad.

# LITERATURE

## Technical Meetings

"ENGINEERING and Technical Conventions, 1959–1964" is a valuable 29-page booklet which lists national, regional, and state meetings of more than a hundred technical groups. The publication is in three sections. A chronological listing gives date, location, headquarters, meeting title, and sponsoring organization. An appendix lists, in alphabetical order, the organizations, their addresses, and the name and title of the person to contact for further meeting information. There is a three-part index for convenient reference—by technical field, location of meeting, and sponsoring organization. Published by Industrial Relations News Inc., 230 West 41st Street, New York 36, N. Y.; the booklet costs $4.

## Economics of Manpower Market

"AN ECONOMIC Analysis of the Market for Scientists and Engineers" was done by A. A. Alchian, K. J. Arrow, and W. M. Capron, under the sponsorship of The Rand Corporation, 1700 Main Street, Santa Monica, Calif.

The 125-page study attempts to determine whether there is now or has been in the recent past a "shortage" of scientists and engineers, and if so, in what sense a shortage can exist. Reasons for seeking a greater supply of scientists and engineers are discussed, and four possible defects in the economic system that affect demands for scientists and engineers are considered. Arguments about the efficiency of our educational system are evaluated, and a case is made for the policy of differential pay for teachers according to the scarcity of their specialities.

## Marketing Operations

"TOMORROW's Corporate Marketing Operations," a symposium, at the National Association of Manufacturers' 63rd Congress of American Industry, reports the views of seven leading executives. The thesis that marketing is not merely an "isolated function of management" is supported by the character of the panel—representatives of engineering, finance, manufacturing, marketing, and a company president.

Fenton B. Turck, Fellow ASME, was moderator of the panel; Clarence H. Linder, Mem. ASME, and J. Keith Louden, Fellow ASME, were among the panel members.

Copies of the 13-page transcript of the symposium may be obtained from the National Association of Manufacturers, Marketing Committee, 2 East 48th Street, New York 17, N. Y.

## Executive Selection

"EXECUTIVE SELECTION: How Psychologists Can Help" is management's first handbook in the use of psychology as a management tool. The authors, graduate students of the Harvard School of Business Administration, have conducted intensive interviews with psychologists who are currently dealing with management problems. To balance this they interviewed a number of managers who have employed psychologists, particularly in executive selection.

The book follows the process from finding a psychologist, through introducing him to the company, right up to the conclusion reached by the psychologist; how he reports his findings to management and how an executive can weigh the results in the final selection.

The 127-page book costs $12.50, and is published by Management Reports, Box 136, Cambridge 38, Mass.

## Shell Molding

"BIBLIOGRAPHY on Shell Molding" is a selected list of over 200 annotated references to books, reports, and magazine articles, published from 1952 to 1958. It covers all aspects of shell molding, including theory, principles, production practice in large and small ferrous and nonferrous foundries, materials, design, testing methods, equipment, and costs. There are papers on the application of shell molding to the manufacture of waveguides, heaters, electric-motor parts, gears, seal rings, valves, pipe flanges, bells, and the like.

This "ESL Bibliography No. 13" may be purchased from the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.; price is $2.

## Selected Reading

IN AN effort to guide the young engineer to proper and competent sources in cultural and intellectual fields outside of his profession, an ECPD Committee has prepared a brochure, "Selected Reading for Young Engineers." The reading list includes suggestions in the field of biography, travel, history, sociology, psychology, philosophy, natural sciences, and literature.

The pamphlet costs 15 cents; for copies write to: Engineers' Council for Professional Development, Training Committee, 29 West 39th Street, New York 18, N. Y.

### NBS Research

"Research Highlights of the National Bureau of Standards," annual report, fiscal year 1958, is now available. The 138-page book describes in varying detail a wide range of scientific studies, laboratory experiments, instrument developments, and technical publications. The book costs 45 cents and is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

### Air-Pollution Control

Results of a 30-month survey on pollution emissions from petroleum refineries are now complete and have been published by the Los Angeles County Air Pollution Control District on behalf of a Joint Committee representing the APCD, the United States Public Health Service, California State Department of Public Health, and the Western Oil and Gas Association.

The final report entitled, "Emissions to the Atmosphere From Petroleum Refineries in Los Angeles County," marks the ninth and last report prepared under the direction of the joint Federal, State, and District project to evaluate petroleum refining emissions in this area. The final report (Report No. 9) is available at $3 a copy. Earlier reports published by the Joint Project group are available singly at prices ranging from 50 cents to $2, and may also be purchased as complete sets, including Report No. 9, at a total cost of $12.

### Science Information News

*Science Information News* is a new publication of the National Science Foundation. The bimonthly has been designed to meet the need for reporting and exchanging news of world-wide activities in science communication and documentation.

The periodical is available at 25 cents for a single copy and on subscription for $1.25 per year through the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

### Research and Test Reactors

"Research and Test Reactors" is a new book of nuclear-reactor information including data especially declassified for this publication. The 297-page book was published recently by The American Society of Mechanical Engineers.

The volume contains detailed information on 53 research reactors located in the United States and 42 reactors situated in Canada, South America, Western Europe, Asia, and Australia. Power output for those reactors ranges from zero watts to over 175,000 kilowatts, with reactor facility costs from a few thousand dollars to over $50 million. The information is the latest available; as an example, some of the data for the Savannah River 305 Test Pile were declassified as recently as August 19, 1958, so that they could be published in this volume.

The Technical Data Committee of the ASME Nuclear Engineering Division has supervised preparation of this edition. This is the Committee's second publishing effort, the first being "Nuclear Reactor Plant Data: Power Reactors, Volume I." This first volume covered reactors being designed and built for the production of electric power. "Research and Test Reactors, Volume II" is similar in form and organization.

Price of "Research and Test Reactors" is $7.50. The book may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

### Power Boilers

"Suggested Rules for Care of Power Boilers," Section VII, 1959 ASME Boiler and Pressure Vessel Code, recently has been issued. The 52-page section covers rules for routine operation, operating and maintaining boiler appliances, rules for inspection, rules for prevention of direct causes of boiler failures, partial rules for installation, rules for operating and maintaining power boiler auxiliaries, and control of chemical conditions. Copies are $2.25, and obtainable from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

### Flow Measurement

"Flow Measurement," chapter 4 of part 5, Instruments and Apparatus, the latest supplement to ASME Power Test Codes is now available. This 91-page second edition of chapter 4 deals only with the three most extensively used types of differential head metering units, namely, the square-edged orifice, flow nozzle, and venturi tube. Included in this chapter is information on the construction of these three elements, recommended techniques governing tests, necessary equations for computing rate of flow, examples to illustrate the application of typical data, a discussion of tolerances applicable to certain of the factors involved in the measurements, and an outline of the major advantages and disadvantages of various types of primary elements. The supplement costs $5, and may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

### Atmospheric Pollution

"Instruments for the Study of Atmospheric Pollution," third edition, is now available. The report is one of a series of continuous activities of Subcommittee No. 2 on Current Projects and Trends of the ASME Committee on Air-Pollution Controls.

The 23-page revised and up-to-date booklet, with alphabetical reference list appended, costs $2. Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

### Who's Who in Engineering

The 1959 edition of "Who's Who in Engineering," eighth edition, a comprehensive biographical volume of the nation's outstanding engineers, which also includes a directory of engineering and engineering-connected groups, has just been published.

Produced under standards of qualification established by the Advisory Committee of Engineers Joint Council, the publication includes 18,000 engineers.

"Who's Who in Engineering" is published by the Lewis Historical Publishing Company, Inc., 265 West 14th Street, New York 11, N. Y.

### PR for Engineers

"What's Muffling the Voice of the Engineer" was the subject of an Engineering Public Relations Forum sponsored by EJC. A panel of engineers, editors, and public-relations men were the guests of the Public Relations Committee of EJC.

A 25-page booklet, an edited transcript of the Forum, has been prepared and costs 50 cents. Copies may be obtained from Engineers Joint Council, 29 West 39th Street, New York 18, N. Y.

### Personal Appraisal

Young engineers are eager to achieve professional recognition as quickly as possible. The development of technical and personal qualifications and adherence to professional standards are essential to this goal. Engineers' Council for Professional Development now has available a personal appraisal form designed to help the young engineer evaluate his progress in this direction. "Personal Appraisal" is one of six points of the "First Five Years" program planned to aid in the development of young engineers. Copies of the form are 10 cents, and are available from Engineers' Council for Professional Development, 33 West 39th Street, New York 18, N. Y.

## THE SCORE BY SECTIONS AS OF MAY 1, 1959

| | SECTION | Per Cent of Quota |
|---|---|---|
| 1 | Waterbury | 182.1 |
| 2 | Cincinnati | 152.3 |
| 3 | Canton-Alliance-Massillon | 146.4 |
| 4 | Dayton | 142.1 |
| 5 | Worcester | 120.9 |
| 5 | Atlanta | 119.8 |
| 7 | Hudson-Mohawk | 116.7 |
| 8 | Olean | 105.1 |
| 9 | Northwest Florida | 102.6 |
| 10 | West Virginia | 102.2 |
| 11 | Fort Wayne | 96.5 |
| 12 | Central Indiana | 93.4 |
| 13 | Hawaii | 89.6 |
| 14 | Southern Tier | 88.5 |
| 15 | Rock River Valley | 87.7 |
| 16 | Central Michigan | 79.8 |
| 17 | Rochester | 79.3 |
| 18 | Birmingham | 78.7 |
| 19 | Providence | 78.1 |
| 20 | Iowa-Illinois | 76.0 |
| 21 | Delaware | 74.7 |
| 22 | Anthracite-Lehigh | 73.7 |
| 23 | Youngstown | 73.7 |
| 24 | Metropolitan | 72.4 |
| 25 | Mid-Hudson | 70.2 |
| 26 | Central Iowa | 69.8 |
| 27 | Milwaukee | 68.5 |
| 28 | North Alabama-Mississippi | 67.7 |
| 29 | Fairfield County | 65.7 |
| 30 | Nebraska | 65.3 |
| 31 | Detroit | 64.8 |
| 32 | Pittsburgh | 63.8 |
| 33 | Minnesota | 63.0 |
| 34 | Erie | 59.3 |
| 35 | Chicago | 57.8 |
| 36 | Akron | 56.6 |
| 37 | Baltimore | 56.3 |
| 38 | Kansas City | 56.1 |
| 39 | Cleveland | 55.9 |
| 40 | Central Illinois | 55.0 |
| 41 | Columbus | 54.7 |
| 42 | San Diego | 52.5 |
| 43 | Western Washington | 51.4 |
| 44 | Syracuse | 48.8 |
| 45 | Western Massachusetts | 48.4 |
| 46 | Columbia Basin | 47.8 |
| 47 | Mid-Jersey | 47.6 |
| 48 | Boston | 46.5 |
| 49 | Arizona | 46.3 |
| 50 | Sabine | 43.6 |
| 51 | Philadelphia | 41.8 |
| 52 | Westmoreland | 41.0 |
| 53 | Central Savannah River Area | 40.0 |
| 54 | New London | 39.7 |
| 55 | New Haven | 38.4 |
| 56 | Inland Empire | 37.4 |
| 57 | New Mexico | 36.7 |
| 58 | Piedmont-Carolina | 34.9 |
| 59 | East Tennessee | 34.6 |
| 60 | St. Louis | 34.0 |
| 61 | San Francisco | 33.8 |
| 62 | Ontario | 33.6 |
| 63 | Utah | 31.1 |
| 64 | South Texas | 29.5 |
| 65 | Savannah | 28.7 |
| 66 | Toledo | 28.6 |
| 67 | Central Kansas | 25.3 |
| 68 | Rocky Mountain | 23.5 |
| 69 | Mid-Continent | 22.7 |
| 70 | Louisville | 22.2 |
| 71 | Central Pennsylvania | 21.7 |
| 72 | Los Angeles | 19.6 |
| 73 | Hartford | 17.6 |
| 74 | Buffalo | 16.0 |
| 75 | Virginia | 15.7 |
| 76 | Mexico | 15.0 |
| 77 | North Texas | 14.7 |
| 78 | New Orleans | 14.2 |
| 79 | Eastern North Carolina | 13.2 |
| 80 | Oregon | 12.6 |
| 81 | Washington, D. C. | 12.2 |
| 82 | Greenville | 12.1 |
| 83 | St. Joseph Valley | 11.3 |
| 84 | Miami | 5.7 |
| 85 | Chattanooga | 4.8 |
| 86 | Northern New England | 2.5 |
| 87 | Mohawk Valley | 1.2 |
| 88 | Florida | 0.4 |
| 89 | Susquehanna | 0.2 |

Cincinnatians mark their achievement as the first community in the nation "over-the-top" in all Founder Society sections in the United Engineering Center campaign. $45,120 already has been pledged by 883 members. Ernest B. Fields, president, Cincinnati Gas & Electric Co., chairman of the Cincinnati Sponsor Group which led the Member Gifts Campaign in the Queen City, receives a token of appreciation from the local Section representatives. *Left to right:* Cornelius Wandmacher, University of Cincinnati, chairman for ASCE Cincinnati Section; Julian E. Tobey, Appalachian Coals, Cincinnati representative, AIME Ohio Valley Section; Ernest B. Fields; Lester L. Bosch, partner, Bosch & LaTour, general chairman and chairman for ASME Cincinnati Section; Kenneth H. Pettengill, Arnold Hoffman & Co., chairman for AIChE Ohio Valley Section; Willard A. Farris, Corps of Engineers, USA, chairman for AIEE Cincinnati Section.

# ASME Lags in Building Campaign

*Record of Achievements for United Engineering Center Is Poor*

### UEC Building Fund (as reported on May 8, 1959)

Member Gifts Campaign Status

| | Quota | Subscriptions | Number of Subscribers | Per Cent of Quota |
|---|---|---|---|---|
| ASCE | $800,000 | $ 491,478.38 | 7,916 | 61.43 |
| AIME | 500,000 | 270,423.13 | 3,832 | 54.08 |
| ▶ASME | 800,000 | 501,359.20 | 10,213 | 62.67 |
| AIEE | 900,000 | 745,566.86 | 19,820 | 82.84 |
| AIChE | 300,000 | 290,815.43 | 6,904 | 96.94 |
| AICE | 80,000 | 20,768.33 | 41 | 25.96 |
| AIIndE | 70,000 | 19,424.00 | 484 | 27.75 |
| SWE | 7,000 | 2,162.00 | 7 | 30.89 |
| AWS | 60,000 | 4,614.17 | 53 | 7.69 |
| ASHRAE | ... | 541.00 | 23 | ... |
| Other | ... | 7,328.91 | 197 | ... |
| Total Member Gifts | | $2,354,426.41 | 49,488 | |

The ASME Member Gifts Campaign, after 14 months of activity, is still short of its goal by more than $300,000. A few Sections have reached or exceeded their quotas, but the majority have made little or no measurable progress.

Although ASME's percentage of quota reached is not the lowest of all participating societies, its record of achievement is substantially exceeded by several others. The American Institute of Chemical Engineers, for example, has reached more than 95 per cent of its quota, and the American Institute of Electrical Engineers has received contributions from twice as many members as has ASME.

Since an obligation has been assumed by ASME, the consensus is that the Society will reach its quota. Underscoring the need for speedier completion of the Member Gifts Campaign, however, is the fact that, at the present rate, it would take the Society another year to reach its quota. Originally the campaign was to be completed in November, 1958.

Although the disappointing rate of return has contributed to delay in construction of the Center, United Engineering Trustees recently announced a new schedule for future work. It calls for completion of working drawings by August 30, confirmation of guaranteed limit of cost, by September 30, and commencement of construction on October 15 of this year.

Construction is scheduled for completion on March 15, 1961, with final occupancy requirements to be finished by July 1, 1961. ●

# THE ASME NEWS

## 1959 Joint ASME-AIChE Heat Transfer Conference to Be Held at University of Connecticut, Storrs, Conn., Aug. 9–12

The campus of the University of Connecticut at Storrs will be the site of the Third Annual ASME-AIChE Heat Transfer Conference sponsored by the ASME Heat Transfer Division and the AIChE Heat Transfer Division.

Twelve technical sessions have been announced by the Technical Program Committee. The ASME portion of the program is comprised of 15 technical papers to be presented by the authors.

Several plant trips have been scheduled including visits to the Pilot Radiator Laboratory, Heat Exchanger Laboratory, and Radiator Test Stands of the Canel plant of Pratt & Whitney. Advance reservations and proof of U. S. citizenship are required. The Combustion Engineering plant has a trip planned limited to 35 registrants only. Proof of U. S. citizenship also is required. Available to interested persons will be a visit to Critical Facilities, Mechanical Laboratory, Material Development Laboratory, and possibly the Submarine Prototype Power Plant.

Events for the women have been planned and baby-sitting facilities will be provided for those who intend to bring the whole family. Among the high lights on the social agenda for the family will be a "genuine" New England shore clambake.

All engineers interested in attending this Conference are urged to register in advance so that the Host Committee will have sufficient time to provide adequate housing.

### ▶MONDAY, AUGUST 10

**Session 1** — **10:00 a.m.**

**Fluid Mechanics and Heat Transfer in Vertical Falling Film Systems,**[1] by *A. E. Dukler*

**Measurements of Average Heat-Transfer Coefficients for Helium and $H_2$ Flowing in a Smooth Tantalum Tube at High Surface Temperature,**[1] by *H. J. Newman*

**Heat Transfer to Fluids Flowing With Velocity Pulsations in a Pipe,**[1,2] by *F. E. Romie*

**Heat Transfer in Flow Through Rotating Ducts,**[1,2] by *C. Y. Kuo, H. T. Iida, J. H. Taylor,* and *F. Kreith*

**Session 2** — **10:00 a.m.**

**Triangular Grids for Heat-Flow Studies,**[1] by *G. M. Dusinberre*

**Effect of Thermocouple Cavity Near Heat Sink Surface on Sink Temperature Distribution and Its Measurement,**[1] by *J. B. Beck* and *H. Hurwicz*

**Measurement of Thermal Conductivities of Gases at High Temperature,**[2] by *R. G. Vines* (Paper No. 59—HT-2)

**Thermal Conductivity of Some Mesomorphic Compounds,**[1] by *J. B. McCoy* and *L. S. Kowalczyk*

**Session 3** — **2:00 p.m.**

**Approximate Theory for Film Boiling on Vertical Surfaces,**[1] by *Y. Y. Hsu* and *J. W. Westwater*

**Equivalent Thermal Diffusivity and Heat Transfer in Boiling,**[1] by *J. Chang* and *N. W. Snyder*

**Populations of Active Sites in Nucleate Boiling Heat Transfer,**[1] by *R. F. Gaertner* and *J. W. Westwater*

[1] Paper not available—see box on this page.
[2] Reviewed and approved papers; all others still in process of review.

### Availability of Papers

ONLY numbered ASME papers in this program are available in separate copy form until June 1, 1960. Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, New York. Prices are 40 cents to members of ASME and 80 cents each to nonmembers. Payment may be made by check, U. S. postage, free coupons, or coupons may be purchased from the Society. The coupons in lots of ten are $3 to members and $6 to nonmembers. Papers must be ordered by the paper numbers in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the Conference.

**Role of Surface Conditions in Nucleate Boiling,**[1] by *P. Griffith* and *J. D. Wallis*

**Session 4** — **3:00 p.m.**

**Radiant Interchange Within an Enclosure—Parts 1, 2, 3,**[1,2] by *R. V. Dunkle* and *J. T. Bevans*

**Heat Transfer From Pre-Mixed Gas Fumes in a Cooled Tube,**[1] by *D. W. Sundstrom* and *S. W. Churchill*

### ▶TUESDAY, AUGUST 11

**Session 5** — **9:30 a.m.**

**Variable-Density Single-Fluid Model for Two-Phase Flow With Particular Reference to Steam-Water Flow,**[1,2] by *S. G. Bankoff*

**Effect of Electrolytic Gas Evolution on Heat Transfer,**[1] by *F. O. Mixon*

**Two-Phase Flow Rates and Pressure Drops in Parallel Tubes,**[1] *by H. L. Folts* and *R. G. Murray*

**Theory of Local Boiling Burnout and Its Application to Existing Data,**[1] by *L. Bernath*

**Natural Circulation Loop Heat Transfer,**[1] by *J. H. Boggs*

**Session 6** — **9:30 a.m.**

**Radiation Fin Effectiveness,**[1] *by J. G. Bartas* and *W. Sellars*

**Radiation Fin Efficiency for One-Dimensional Heat Flow in a Circular Fin,**[1,2] by *R. L. Chambers* and *E. V. Somers*

**Spectral Characteristics of Fabrics from 1-23 Microns,**[1,2] by *R. V. Dunkle, F. Ehrenberg,* and *J. T. Gier*

**Radiant Heat Transfer Through the Atmosphere,**[1] by *J. H. Chin* and *S. W. Churchill*

**Session 7** — **2:00 p.m.**

**Condensation on a Rotating Horizontal Surface,**[1] by *K. O. Beatty, Jr.,* and *S. S. Nandapurkar*

**Condensation of a Vapor in Pressure of a Noncondensing Gas,**[1] by *W. W. Akers, J. E. Crawford,* and *S. H. Davis, Jr.*

**Heat Transfer During Condensation Inside a Horizontal Tube,**[1] by *W. W. Akers* and *H. F. Rosson*

**Local Heat-Transfer Coefficients and Pressure Drops for Refrigerant-22 and Condensing in a Horizontal Tube,**[1] by *M. Altman, R. H. Norris,* and *F. W. Staub*

**Large-Scale Plant Analysis of Colburn-Hougen Analogy,**[1] by *D. Q. Kern,* et al.

**Session 8** — **3:00 p.m.**

**Freezing of a Growing Liquid Column,**[1,2] by *G. Horvay*

**Temperature Distribution in Solids With Electric-Heat Generation and Temperature Dependent Properties,**[1] by *R. P. Stein* and *M. U. Gustein*

**Transient One-Dimensional Heat-Conduction Analysis for Heterogeneous Structure Including an Arbitrary Surface,**[1] by *M. L. Miller*

**Digital Computer Solution for Transient Heat-Transfer Problems,**[1] by *J. T. Anderson, J. M. Boltje,* and *W. K. Koffel*

▶WEDNESDAY, AUGUST 12

**Session 9** — **9:30 a.m.**

**Conical Turbulent Boundary-Layer Experiments and a Correlation With Flat Plate Data,**[1,2] by *W. S. Bradfield*

**Stream Slip-Theoretical Prediction From Momentum Model,**[1] by *S. Levy*

**Magnetohydrodynamic Effect Upon Heat Transfer for Laminar Flow Across a Flat Plate,**[1,2] by *R. D. Cess*

**Laminar Transfer from Isothermal Spanwise Strips on a Flat Plate,**[2] by *H. H. Sogin* (Paper No. 59—HT-1)

**Heat Transfer to Laminar Flow in Circular Tube With Arbitrary Circumferential Heat Flux,**[1] by *W. C. Reynolds*

**Session 10** — **9:30 a.m.**

**Determination of Core Dimensions of Cross Flow Gas to Gas Heat Exchangers,**[1] by *P. S. Lykoudis* and *R. M. Shastri*

**Heat-Transfer Rates for Parallel Flow of Liquid Metals Through Tube Bundles,**[1] by *O. E. Dwyer, A. Friedland,* and *P. S. Tu*

**Assessment of Heat-Exchanger Data,**[1] by *S. K. Jenssen*

**True Temperature Difference in a 1–2 Divided Flow Heat Exchanger,**[1] by *D. L. Schindler* and *H. T. Bates*

**Organization of Heat-Exchanger Program on Digital Computer,**[1] by *J. J. Taborek*

**Session 11** — **2:00 p.m.**

**Conductive Heat Transfer in a Re-Entry Body Analysis of Computational Methods and Their Reliability,**[1] by *H. Hurwics* and *M. S. Klamkin*

**Heat Transfer From Yawed Cylinders in Rarefied Air Flows,**[1,2] by *L. V. Baldwin, V. A. Sandborn,* and *J. C. Lawrence*

**Influence of Free Stream Turbulence on the Local Heat Transfer From Cylinders,**[1,2] by *R. A. Seban*

**Unsteady Turbulent Heat Transfer in Tubes,** by *E. M. Sparrow* and *R. Siegel* (Paper No. 59—HT-16)

**Session 12** — **3:00 p.m.**

**Heat Transfer to a Packed Bed From Finned Tubes,**[1] *B. D. Phillips*

**Effective Bed Thermal Conductivity of a Bed Packed With Molecular Sieve Adsorbent,**[1] by *B. D. Phillips* and *F. W. Leavitt*

**Heat Transfer in Baffled, Jacketed, Agitated Kettles,**[1] by *G. Brooks* and *G. J. Su*

**Heat Transfer to a Single Cooling Tube in a Moving Bed Reactor,**[1] by *D. J. London* and *K. O. Beatty, Jr.*

[1] Paper not available—see box on page 130.

[2] Reviewed and approved papers; all others still in process of review.

# FIGHT INFLATION

## *ASME Calls on Members to Act to Check Inflationary Forces. The Month Ahead Is Critical*

Inflation and continuing upward price trends loom as important adverse factors affecting our future prospects and well being, according to the ASME Board on Public Affairs. An increase in prices not only imposes tremendous hardship on a large segment of our people who must live on fixed incomes, but it affects millions whose incomes fail to keep up with a continuous inflationary spiral.

Even more damaging, however, can be the fact that the resulting increased costs can price our goods out of both domestic and export markets and seriously hamper us in our efforts to obtain and maintain full employment.

I believe it is accepted as the best economic opinion that inflation comes about (1) by continuing federal and local government budget deficits caused by undue spending of money obtained by borrowing, (2) by the upward push on prices of the "wage-price spiral" under the influence of union pressure, and (3) by the over-expansion of bank credit to finance an unwise expansion of facilities or consumer purchases on credit.

In times of business depression and heavy unemployment some of the foregoing measures may be good and may serve to hasten recovery. When business begins to recover, as at present, and when unemployment begins to approach normal lower levels, such inflationary measures can be pursued only at the nation's peril.

President Eisenhower has called on Congress and local governmental agencies to balance their budgets, to make current income from taxes equal necessary expenditures in so far as possible. He has asked labor and management to act in the near future so as to make further price increases unnecessary.

It will be in the public interest, in the interest of every individual, and in the interest of ASME which is facing the effects of inflationary costs, if each member of our Society exerts his utmost proper influence on his Congressmen, his municipal and state officials, and his associates in industry to urge them to make every possible effort to stop this inflationary price spiral now. . . . .before the Federal spending budget becomes fixed in the months of June and July. Act now!

*Glenn B. Warren*
**President, ASME**

# Helpful Hints in Planning a Meeting

THERE is no known formula, equation, or recipe handy for the meeting planner which automatically promises a successful, profitable event.

However, here are the findings obtained by a 26-member convention-evaluation team financed by the W. K. Kellogg Foundation:

***Exhibits:*** Received the highest rating. Members appreciate exhibits that inform, that explain new ideas and products. While they do not go for exhibits that try to overwhelm and oversell, they appreciate talking with company representatives who can answer questions about product use.

***Speakers:*** "Topics" (subject matter) far outweighed "Speakers' names" as drawing cards. Three fourths of the interviewees when asked why they chose a particular meeting, answered because of the "topic," while only two per cent said "speakers."

***Audience participation:*** Little correlation was found between successful sessions and audience participation.

***Advance preparation:*** Discussion groups that were brought together two or more weeks before the convention received high ratings. Adequate preparation was stressed as the key to success.

***General sessions:*** Received the most complaints. Findings showed that sessions were too long. Reduce the preliminaries was the popular opinion. By the time people sit through the welcome, opening remarks, invocation, greetings from allied organizations, announcements, reports, recognition of a host of platform guests and introductions, they just are not in proper condition to be inspired.

***Chairmen:*** Generally speaking, chairmen received a clean bill of health from the interviewees. However, there were three weaknesses mentioned: (1) Failing to sense the mood of the audience and consequently to make program adjustments; (2) not handling audience participation too adroitly, and inability to leave a topic at the right time; and (3) not providing for some kind of summary at the end of the meeting.

# ASME Pittsburgh Section Conference on Pollution Marks City's Bicentennial Celebration

*Three ASME members honored at banquet*

G. Sinding-Larsen, *left*, president, Pittsburgh Piping and Equipment Company, receives award of Fellow Grade from E. W. Jacobson

E. S. Howarth, *left*, chief, ME Div., Alcoa Research Labs, chairman, ASME Pittsburgh Section, 1957–1958, receives Certificate of Award from E. W. Jacobson, chief design engineer, Gulf Research and Development Company, and an ASME director

S. B. Ely, *left*, retired mechanical engineering professor, Carnegie Tech, retired superintendent of Bureau of Smoke Prevention, Pittsburgh, receives Fellow certificate from E. W. Jacobson

Prof. Walton Forstall, ME Department, Carnegie Tech, and chairman, ASME Pittsburgh Section, presides at banquet

W. L. Faith, managing director, Air Pollution Foundation, San Marino, Calif., banquet, speaker, discusses Los Angeles' air pollution problems

THE Pittsburgh Section of The American Society of Mechanical Engineers, to mark the Bicentennial Celebration of the City of Pittsburgh, held a conference on pollution problems and solutions, April 20–21, at the Penn-Sheraton Hotel.

Topically the subject was most appropriate. Time and again during the two-day meeting it was evident that the solution of this problem played a major role in the renaissance of Pittsburgh.

Mechanical engineers, the program pointed out, have been key figures in analyzing the many facets of this problem and have contributed greatly in working out practical and reasonable means of minimizing and in some cases eliminating some of the major factors contributing to this problem so that the old designation of "Smoky City" no longer applies to Pittsburgh.

The technical program was designed on a broad plane in order that economic, social, and political as well as technical phases of the question were included in the discussions. Papers of a general nature were presented by government officials, and technical papers by engineers engaged in Pittsburgh industry, who have been involved specifically with air-pollution reduction in the area. The program gave a complete picture of the background and history of the problem; the measures which have been taken to accomplish the tremendous results to date; and those tasks which remain to be done.

The first day of the meeting, April 20, offered four papers of great interest along these lines. The morning session included: "Background of Air Pollution in Pittsburgh—the Forces Which Motivated the Program," given by John Grove, assistant director, Allegheny Conference on Community Development; and "The Pittsburgh Plan and Its Implementation," by T. C. Wurts, Mem. ASME. Adolph Schmidt, president, Allegheny Conference on Community Development, during the afternoon session gave an economic evaluation of the Pittsburgh Program in retrospect. C. A. Bishop, director, chemical process development, and W. W. Campbell, supervising technologist, steam and air

pollution, both of U. S. Steel Corporation, spoke on "Pittsburgh Looks to the Future—Research Program."

Col. John F. Laboon, executive director and chief engineer of the Allegheny County Authority, spoke at the opening luncheon. Also present was Mayor Thomas J. Gallagher of Pittsburgh, who spoke briefly about the Pittsburgh Plan. Colonel Laboon, currently working on the City's pressing problem of sewage disposal, reported that his organization will put into operation, within the next few weeks, a new plant servicing a large portion of the Pittsburgh area. He pointed out that Pittsburgh's rivers, like those of most other industrial areas, are heavily polluted with mill, mine, and other industrial waste. He stated that it is entirely possible to clean up these streams so that their full recreational and scenic values can be realized.

The banquet, on April 20, was opened by Walton Forstall, chairman of the ASME Pittsburgh Section. Allison L. Bayles, Mem. ASME, was toastmaster. E. W. Jacobson, a director of ASME, presented the honors.

"The kind of honor," said Mr. Jacobson, "is not as important as is the public recognition of the achievement or the services rendered." He outlined the honors ASME confers, emphasizing that to attain an ASME honor it must be recommended by several fellow engineers to the Council of ASME and Council approval must be given.

Then he called on E. S. Howarth, chairman of the Pittsburgh Section, 1957–1958, and presently chairman of the Member Gifts Campaign for the United Engineering Center Fund, to receive the Certificate of Appreciation.

G. Sinding-Larsen, one of this country's outstanding specialists in the field of power piping, was introduced and presented with a Certificate of Fellow grade of membership in ASME.

Sumner B. Ely was also awarded his Certificate of membership grade of Fellow in ASME. Professor Ely was honored for his accomplishments in three careers. From 1892 to 1912, he had a successful and rewarding business career with the Yale & Towne Manufacturing Company, Stamford, Conn. When at the age of 50 years he retired and joined the Engineering Faculty of the Carnegie Institute of Technology. In his second career he is remembered as ". . .a teacher of unusual character, abilities, and professional experience." In 1940, at 70, not wanting to give up working at an early age, Professor Ely started upon his third career. For the next 17 years he was superintendent of the Bureau of Smoke Prevention in Pittsburgh. In making the presentation of the certificate, Mr. Jacobson remarked that the results of Professor Ely's third career amounted to an accomplishment of considerable magnitude and brought Pittsburgh to the attention of the whole world.

The principal speaker of the evening was W. L. Faith, managing director of the Air Pollution Foundation of San Marino, Calif. He spoke on "Air Pollution Problems in Los Angeles and Their Solution." Dr. Faith gave an excellent picture of the background of the problem in Los Angeles, the various solutions and theories to date, and the conclusion that the somewhat unique "smog" problem in Los Angeles is due solely to the olefinic hydrocarbons in automobile exhausts. Several approaches, some promising, to afterburners to be used on automobiles are being investigated, and Dr. Faith believes that the solution to the problem is in sight.

The second day of the meeting offered a unique combination of papers, inspection trips, and entertainment: Two papers, one dealing with the air-pollution problems and solutions in a pulverized-coal-burning steam-generating station, and an inspection of the Frank R. Phillips Power Station, Duquesne Light Company; and the second, on blast-furnace gas cleaning for iron and ferromanganese production, and a visit to the Pittsburgh Coke and Chemical Company, Neville Island, Pittsburgh. The conferees were guests of the Dravo Corporation for luncheon. Late in the afternoon the conference concluded with a boat trip back to Pittsburgh. En route they saw the new Allegheny County Sanitary Authority Sewage Treatment Plant, the plants they had visited earlier, and an interesting waterside view of this highly developed industrial area.

# Passengers, Freight, and European Developments "On the Road" at Railroad Conference

NEW COMFORT for railroad passengers, better freight handling, developments on European rail systems, and mechanized railroad maintenance were some of the topics discussed at the Second Joint Railroad Conference, Chicago, Ill., April 8 and 9, 1959.

There was an attendance of 205 at the two-day sessions sponsored by the Railroad Division of The American Society of Mechanical Engineers and the Land Transportation Committee of the American Institute of Electrical Engineers in co-operation with the Chicago Sections of both organizations.

### Banquet and Luncheons

G. Murray Campbell, vice-president of the Baltimore & Ohio Railroad, delivered the opening remarks at the Banquet. Harold M. Mayer, professor of geography at the University of Chicago, was the principal speaker. His topic was "The Past and Future of Chicago as the Transportation Center of the United States."

At the Thursday luncheon, Bruce C. Gunnell, chairman of the ASME Railroad Division, delivered the opening remarks. The principal speaker was Simon Cottrell, assistant commercial attaché, Consulate General of France. His talk was accompanied by films on the 200-mph speed tests conducted by the French State Railways. The world speed record of 205 mph was achieved by two French-built electric locomotives on the line from Bordeaux to Dax in March, 1955. High speed and punctual operation are characteristic of the French railroads. In 1957, 96.4 per cent of the schedules were met, and over 25,000 miles were operated daily at average speeds in excess of 60 mph. The Mistral makes the 318-mile trip from Paris to Lyon at an average speed of 80 mph, and the Sud-Express the 361-mile trip from Paris to Bordeaux at an average of 73 mph. Operation on 50-cycle a-c—the same current used by industry—permits a lighter catenary, simple and fewer substations which are merely transformers, and a one-third reduction in capital cost. Rails welded into $^1/_2$-mile lengths and

connected by special expansion joints are being used on the main lines. Spring and rubber-baseplate fastening is employed on concrete sleepers with metal cross ties. At Marseille-Saint-Charles one signalman in a main "box" operates the points and signals for 450 routes. This one box replaces ten of the old type and instructions are machine memorized and carried out automatically.

In experiments toward automation, a driverless train, remotely controlled from a substation by radio, started, gathered speed, ran at 75 mph, and slowed down and stopped at an agreed point. Driverless diesel-electric locomotives also shunt and sort trains in a "marshalling" yard. Automatic braking of trains is being tried.

At the Friday luncheon, P. G. Lessman, chairman of the AIEE Land Transportation Committee, delivered the opening remarks, and V. E. Gunlock, chairman of the Chicago Transit Board, spoke on "Horizons for Chicago Metropolitan Area Rapid Transit."

### Technical Papers

In a 93-page report (Paper No. 59—RR-1), P. V. Garin, Mem. ASME, of the Southern Pacific Company, told of "Technical Research on European Railroads." The report was the result of visits to the headquarters or research laboratories of railroads in seven countries of Western Europe during September and October, 1958.

Mr. Garin stated that "the European railway system has been modernized more in the last 10 years than it had been during the previous 50 years." The principal European systems are government-owned or controlled, and with a few notable exceptions operate at a financial loss. There is a greater tendency in Europe for railroads to set the standards for equipment design. Overhead electrification is a primary objective because of the high price of fuel oil and the growing shortage of coal.

High-speed lightweight diesels, differing in a number of respects from American equipment, are replacing steam where electrification is uneconomical. There is a definite preference for hydraulic-drive or hydraulic-mechanical-drive diesels rather than the diesel-electric type.

Shortage of copper, less maintenance, and ability to operate under conditions that would melt the solder and insulation on electric drive, are among the factors favoring the hydraulic or partially hydraulic drive. Rail adhesion twice that of American diesels, or 37 per cent, is achieved without sanding—a major advantage for heavy-grade operation.

Passenger service which "actually betters the elapsed time from city to city as compared to the air travel, including airport connections, at a lower cost" is becoming increasingly popular. It is made possible by diesel-powered, fixed-consist, air-conditioned trains known as Trans-Europ-Express. Customs and immigration inspection are provided on the train to prevent stops at the border, and engine changes are unnecessary.

The Office for Research and Experiments, ORE, of the International Union of Railways co-ordinates research by the member railroads. ORE permits the railroads doing research work to submit invoices and receive credit against their assessed contributions. A permanent headquarters staff of 12 engineers and 25 supporting personnel is maintained, but ORE does not operate its own research laboratory.

Door-to-door handling of merchandise is being developed. Some methods are similar to American piggybacks. One, a sort of piggyback in reverse, carries entire railroad flatcars (smaller than those in the U. S.) on 24-wheeled rubber-tired highway vehicles. Another "kangaroo" system lowers a portion of the flatcar body to accommodate semitrailer wheels and permit a lower profile. There are a number of other variations.

In addition to the French developments reported in the luncheon talk by Mr. Cottrell, experiments continue with free-piston gas-turbine locomotives, although Mr. Garin reported little enthusiasm for these in other countries. The original experimental locomotive placed in passenger service in 1952 had 1000 hp and a turbine speed of 12,000 rpm. A similar locomotive developing 2400 hp with two free-piston generators is now under construction.

A. G. Dean, Mem. ASME, chief engineer of the Railway Division of the Budd Company, described some of the characteristics of the new lightweight air-conditioned, multiple-unit, commuter cars which the Pennsylvania Railroad placed in service last summer. In round numbers, he stated, these are 35 per cent longer than the old ones, weigh 38 per cent less, can accelerate 30 per cent faster with $\frac{1}{3}$ less horsepower, and have about the same top speed.

The other preprinted ASME paper (No. 59—RR-2) by A. D. Edelman, Mem. ASME, assistant chief engineer of the Hyatt Bearing Division of General Motors Corporation, presented a method for comparing the ratings of the roller bearings applied to railroad journals, and a method for determining the effective load on the bearings in this type of application.

# 31st Annual Oil and Gas Power

The Oil and Gas Power Division of The American Society of Mechanical Engineers held its Annual Conference and Exhibit for 1959 April 20-23, in Houston, Texas. Some 570 engineers made Houston's famed Shamrock-Hilton Hotel their headquarters for four days of technical sessions, social events, and field trips.

The men whose interests lie in the design, construction, and operation of heavy internal-combustion engines made this the biggest divisional conference of their history (about 20 attended the first meeting in 1928). The conference, sponsored by the Division with the cooperation of the ASME's South Texas Section, was the thirty-first for OGP.

### Power for Texas Industry

It is the Division's custom to focus attention on the oil-and-gas-power interests of the area in which the conference is held. Thus, for 1959, the emphasis was directed toward the operation and maintenance of internal-combustion-engine equipment as used by pipelines.

OGP's custom of having manufacturers display their products and their recent developments at the Annual Conference has resulted in a closer-knit industry. An engineer sees the products in which he is interested, and makes contacts with the distributors.

This year, the Division inaugurated a new feature: During the second technical session representatives of the 37 exhibitors were allotted three minutes each in which to brief the conference on their new methods, new equipment, and new service facilities around the country.

The second session also heard three reports which were not technical papers in the usual sense. One was a report on "AIEE-ASME Recommended Specifications for Speed Governing of Internal-Combustion-Engine Generator Units," presented by L. J. Moulton. Another covered "The Fifth Edition DEMA Standard Practices for Low and Medium-Speed Stationary Diesel and Gas Engines," presented by T. M. Robie. The third reported on "Development of

Harold Grasse, *left*, Vice-President, ASME region VIII, and W. H. Everett, *right*, Welcome Luncheon Speaker, at OGP Meeting

O. H. Moore, *left*, presents OGP plaque to South Texas Section. A. A. Rasmussen accepts for Section.

# Conference and Exhibit in Houston

Dr. Harold Vagtborg speaks on "More and More From Less and Less" at OGP banquet

ASME-OGP Division Power Cost Reports," presented by C. P. Ketler.

OGP believes that at least one technical session should be a panel discussion. At Houston, there were two such discussions. One covered "Engine Foundations—Design, Theory, Construction," and the second took up "Engine Lubrication and Oil Filtering."

While the conference's technical papers covered the range from theoretical development to the engine-users' experience, in general the papers may be said to have been "practical." Example: In Session 3, on the morning of April 21, a paper was concerned with engines for an Alcoa plant at Point Comfort, Texas, which has probably the largest total horsepower of any plant in the world using internal-combustion engines.

The entire proceedings of the conference were taped, and will be printed, becoming available in about six months.

On the afternoon of Tuesday, April 21, there were two field trips. One was a 130-mile circle tour in chartered buses, arranged by the South Texas Section. The trip included visits to three pipeline pumping stations. At the same time, there was a boat trip down the Houston Ship Channel, about 15 miles to the San Jacinto Monument and the Battleship *USS Texas*.

### The Speakers' Platform

Monday night there was a special lecture on "Automation in the Oil and Gas Industry." The lecturer was W. S. Quimby, Senior Technologist, Research and Technical Department, The Texas Company, Beacon, N. Y.

At the Welcome Luncheon, Monday noon, toastmastered by A. A. Rasmussen, chairman of the ASME's South Texas Section, the main speaker was H. Hume Everett of The Ohio Oil Company and chairman of the American Citizenship Committee of the State Bar of Texas.

Mr. Everett's question was: "Does our profession come first, or are we to be Americans first?" His reply was that the dangers to our constitutional republic compel us to be Americans first—if we are to remain American professional men and women with freedom. This carries the tremendous responsibility of knowing more about our government, and of inculcating a knowledge of constitutional government into those who will be and are being trained in our profession. If they are not trained to know, love, live by, and act in accordance with the principles of our historic government of freedom and responsibility, they cannot expect to be anything but numbers.

"Our form of government," he said, "is a constitutional republic—not a democracy. The word 'democracy' does not appear in the Declaration of Independence, in the Constitution, or in the Bill of Rights."

At the banquet, on the evening of April 22, the presiding officer was O. H. Moore of Tennessee Gas Transmission Company, Houston, and chairman of the OGP's Executive Committee. Harold Grasse of Black & Veatch, Kansas City, Mo., and Vice-President of ASME's Region VIII, served as toastmaster.

Banquet night was the occasion for the awards. A citation for outstanding service to the ASME was awarded to P. B. Jackson, past-chairman, of the OGP Division.

### Awards for Technical Papers

It is the custom of OGP to make awards for technical papers which have been judged outstanding after presentation at previous meetings. Two such awards were made on this occasion: One to H. G. Holler of Nordberg Manufacturing Company, Milwaukee, Wis., and Laskar Wechsler of the Bureau of Ships, Department of the Navy, for their paper, "Development of a Lightweight, High-Output, Four-Cycle Diesel Engine for Naval Service." The other went to W. M. Kauffman of Worthington Corporation, Buffalo, N. Y., for his paper, "Development of a Turbocharged Uniflow Two-Cycle Spark-Ignition Gas Engine."

The principal speaker was Dr. Harold Vagtborg, President of Southwest Research Institute, San Antonio, Texas. His subject: "More and More From Less and Less." His point: We have a seemingly large store of natural resources, but they become more and more difficult to get—and we need to make the best use of these resources.

Dr. Vagtborg pointed out that there is nothing being discovered today—or any time in the future—which wasn't always a fact. We don't create facts: We merely discover them. Research uncovers the facts.

## Availability List—Oil and Gas Power Conference

The papers in this list are available in separate copy form until February 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

**59—OGP-1** Development and Application of a Small, Four-Cycle, Turbocharged Gas-Compressor Engine, by W. M. Kauffman and D. E. Schultz

**59—OGP-2** Evaluation of Corrosion in Diesel Cylinders, by J. M. A. Van Der Horst and W. Schultze

**59—OGP-3** Production Design of a Modern, Axial-Flow, Positive-Displacement, Rotary Compressor, by W. C. Fischer

**59—OGP-4** Lubrication! Sez Who?, by R. L. Churchwell and F. J. Kokas

**59—OGP-5** Development of a High-Compression-Ratio Gas Engine, by R. D. Henderson and J. C. Hallinan

**59—OGP-6** Advantages of Tailor-Made Construction Contracts, by R. F. Small

**59—OGP-7** Engine-Waste Heat Utilization in a High-Speed, Geared Steam Turbine, by J. C. Georgian

**59—OGP-8** Mechanical Isolation of Torsional Vibrations, by G. A. Dorton

**59—OGP-9** A Field Study of Gas Engine Lubricants, Part 2, by C. M. Floyd

**59—OGP-10** Installation, Operation, and Maintenance of Turbocharged Gas-Engine Compressors, by W. H. Payne and G. H. Bollman

Bathtub reactor of Michigan's Phoenix Project. "Hope the water's deep enough. . ."

J. W. Daily, M.I.T., Technical Session Chairman, *left*, with J. Parmakian, Chairman, Executive Committee

Pierre Danel, *left*, Grenoble, France, with J. W. Holl, of Penn State

Prof. Ayres, Oceanographer: "I, too, am a hydraulicist. . ."

# First ASME Hydraulics Conference at U of M a Success

THE Hydraulic Division of The American Society of Mechanical Engineers held its first National Conference, April 13–15, 1959, at the University of Michigan, Ann Arbor, Mich. The conference was sponsored by the Division in cooperation with the ASME Detroit Section.

This first independent gathering of the hydraulics engineers was proposed four years ago by Dr. R. G. Folsom, now president of Rensselaer but then director of Engineering Research at the University of Michigan and a past-chairman of the ASME's Hydraulic Division. Dr. Folsom recommended that the Division hold its initial national conference at Michigan in 1959 when the University's new hydraulics laboratory was expected to be in operation. It was so ordered and done. A feature of the conference was the opportunity to visit the new hydraulics building on the North Campus.

One hundred and forty engineers attended the conference, a number of them from Canada, one from France. Dr. Pierre Danel of France noted that it was fitting that our hydraulics conference be held in a state known as the "Water Wonderland." Wonderland or not, the conference heard and discussed 20 papers that represented a high quality of technical investigation.

### The Rackham Auditorium

At 9:30 on the morning of April 13, the first session convened in an auditorium of the Rackham Building, a structure given to the University by Horace Rackham, one of Henry Ford's early backers. The auditorium is famed as the place in which Dr. Salk and Dr. Francis met the press, announcing to the world the success of the Salk vaccine.

S. S. Attwood, the University's Dean of Engineering, made a speech of welcome. Dr. Folsom, who is a Director of the ASME, also spoke, expressing thanks to the University for its hospitality to the Conference. The first session then proceeded to the consideration of two technical papers on cavitation.

Later in the conference, the Division's Chairman, John Parmakian, observed that there had been a notable difference in the technical content of the papers as compared with those heretofore presented by the Division at the Society's Annual Meetings. At Ann Arbor there was more fundamental research, more emphasis on advanced problems of the hydraulics engineer.

"Where the Annual Meeting papers are more general," he said, "here we got right down to basic hydraulics."

A stumbling block to such a meeting has been the fact that the Division seemed to be spread horizontally, seven subcommittees pursuing independent lines of inquiry. Dr. Folsom once remarked sadly that the Division was an administrative canopy under which the seven subcommittees operated. At Ann Arbor, the theme might well have been "Divisional Unity." Technical sessions were uncommonly well attended in spite of the separation of the subjects—cavitation, hydraulic turbines and water hammer, fluid mechanics, pumping machinery and compressors, and fluid-power systems. The 20 papers added up to a solid advance in hydraulic engineering.

A hint of the stimulus generated by the Conference can be found in the following figures. Papers presented by the Division at last year's Annual Meeting: 17. It had been assumed that the Conference would cut deeply into the next year's offerings. Papers now under consideration for the 1959 Annual Meeting: 17.

### The Luncheon Circuit

Supplementing the technical sessions, the Conference offered three luncheons, two field trips, and a banquet. At the Monday luncheon, the Conference heard from Dr. Pierre Danel, chief research engineer, Neypric Company, Grenoble, France. Dr. Danel presented his paper on cavitation, a paper which had not been preprinted but which was made available in mimeograph form to all those attending the Conference. He discussed the investigation of cavitation by scale models. In effect, his paper replaced one by M. Murakami on vibration of water turbine draft tubes, which has been put over to the next Annual Meeting.

A feature of this first luncheon was the presentation of a certificate of Fellowship in the ASME to Dr. G. F. Wislicenus, professor of aeronautical engineering and director of the Garfield Thomas Water Tunnel at The Pennsylvania State University. W. C. Osborne, chairman of the Division's Honors Committee, made the presentation.

Tuesday noon, the luncheon speaker was G. V. Edmonson, associate dean of the University's College of Engineering. Dean Edmonson told of the new facilities on Michigan's North Campus which the Conference was invited to visit that afternoon.

The University has developed an entirely new campus, devoted primarily to graduate studies and research in many fields of engineering. New facilities include the Phoenix Memorial Laboratory for research on peaceful uses of atomic energy, the Ford Nuclear Reactor,

Monday Luncheon.
*Left to right:* R. H. Pepper, J. Parmakian, S. S. Attwood, P. Danel, J. W. Daily, R. G. Folsom, G. F. Wislicenus, and J. W. Robertson.

the Automotive Engineering Laboratory, the Aeronautical Laboratory and Wind Tunnel, and the Fluids Engineering Laboratory.

### Tunnel of Science

Dean Edmonson discussed the philosophy of the new laboratories: "Space which no longer serves the needs of both laboratory teaching and research is obsolete." He described the Fluids Engineering Building, telling of problems which arose. Sample: "We found we needed a boat for getting around in subterranean passages."

That afternoon, University buses were made available to take visitors to the North Campus, where the Conference toured the labs.

There was also a trip to the Enrico Fermi Nuclear Reactor on Lake Erie, near Monroe, about 30 miles from Detroit. (An organization of industrial firms have formed the Power Reactor Development Corporation to build, own, and operate the reactor. They will sell steam to Detroit Edison—DE is building an adjacent power plant, the PRDC absorbing the loss.) This is a breeder reactor, producing 1.2 lb of plutonium fuel for every pound of U 238 it consumes.

On the evening of Tuesday, April 14, the Conference transferred its activities to the American Legion Hall, off the campus, for the banquet. Practically the entire conference was housed in the University's Union Building, stopping place for all VIP visitors to Ann Arbor, from queens (Juliana) on down. Buses took the Conference from the Union to the banquet hall.

The speaker of the evening was an oceanographer who has turned his attention to the Great Lakes, and who spoke of them as "our last frontier." Thus even the banquet maintained the fluid theme of the Conference. (Yes, the hydraulic engineers "got their feet wet" at this first national gathering.)

The speaker was Prof. John C. Ayres of U of M's Department of Zoology and the Great Lakes Research Institute. He described the "physiological ages" through which all lakes pass, and stated that the Great Lakes are: "The last major source of potable fresh water in the world."

### The Story of the Lakes

He explained that a lake passes through a series of recognizable stages between its birth and its degeneration into a marsh. It goes through a period of development during which it cuts its beaches, develops its watershed and drainage area, establishes its outlet, and generally takes its place in the environment. There follows a long period of "maturity"—and then come the degenerative changes leading to senescence.

"In senescence," he said, "the lake becomes shallower, warmer, weedier, less clear, and accumulates chemicals. A lake 'dies' by becoming so filled-in that the marsh plants take over, and it ceases to be a lake."

Of the Great Lakes, Superior is the youngest, in early maturity. Erie, the oldest, is in mid-senescence. Professor Ayres discussed the degenerative influences working on Erie. He said that we could delay the aging of the other Great Lakes by the same kind of conservation that preserves our forests and our game.

"Man cannot slow the aging of a lake," he said, "but he can avoid speeding it up. If the Great Lakes are to be retained as resources, management and wise use must be instituted."

At the third luncheon, on the final day of the Conference, Chairman Parmakian called for frank discussion of the meeting, with a view to the planning of the Division's future national conferences. Should a conference be short, with overlapping technical sessions? . . .How many social functions should there be? Next year's conference will be held jointly with the Society's Gas Turbine Power Division, in Houston, Texas. The scheduled date: March 6–9, 1960.

Mr. Parmakian, this year's Chairman, is head of the Technical Engineering Analysis Section of the Bureau of Reclamation in Denver, Colo. In addition to his service as Chairman of the Hydraulic Division, Mr. Parmakian has just finished a tour as Chairman of the ASME's Rocky Mountain Section.

At Ann Arbor, the Local Arrangements Committee, all on the staff of the University, were: F. K. Boutwell, Prof. H. R. Colby, Prof. G. V. Edmonson (Chairman), Prof. K. W. Hall, F. C. Moncrieff, Prof. R. C. Porter, F. H. Westervelt, and Prof. J. L. York.

## Availability List—Hydraulic Conference

THE papers in the list are available in separate copy form until February 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

**59—Hyd-1** Three-Dimensional Flow Considerations in the Design of Turbines, by W. L. Stewart, W. J. Whitney, and H. J. Schum

**59—Hyd-2** An Experimental Investigation of Radial Thrust in Centrifugal Pumps, by A. Agostinelli, D. Nobles, and C. R. Mockridge

**59—Hyd-3** Crossover Systems Between the Stages of Centrifugal Compressors, by G. O. Ellis

**59—Hyd-4** Pressure Losses in Smooth Pipe Bends, by H. Itō

**59—Hyd-5** Ejector-Nozzle Flow and Thrust, by H. E. Weber

**59—Hyd-6** On the Three-Dimensional Turbulent Boundary Layer Generated by Secondary Flow, by J. P. Johnston

**59—Hyd-7** Influence of Trailing-Edge Geometry on Hydraulic-Turbine-Blade Vibration Resulting From Vortex Excitation, by Gunnar Heskestad and D. R. Olberts

**59—Hyd-8** Water-Hammer Damage to Oigawa Power Station, by C. C. Bonin

**59—Hyd-9** Chamber Dimension Effects on Induced Flow and Frictional Resistance of Enclosed Rotating Disks, by J. W. Daily and R. E. Nece

**59—Hyd-10** Volute Pressure Distribution, Radial Force on the Impeller, and Volute Mixing Losses of a Radial Flow Centrifugal Pump, by H. W. Iversen, R. E. Rolling, and J. J. Carlson

**59—Hyd-11** The Propeller Turbines of the St. Lawrence Power Project, by G. G. Fintak

**59—Hyd-12** The Inception of Cavitation on Isolated Surface Irregularities, by J. W. Holl

**59—Hyd-13** A Shock-Tube Technique to Determine Steady-Flow Losses of Orifices and Other Duct Elements, by George Rudinger

**59—Hyd-14** Separation Prediction for Conical Diffusers, by J. M. Robertson and H. R. Fraser

**59—Hyd-15** Indentation of Metals by Cavitation, by W. H. Wheeler

**59—Hyd-16** The Fluids Engineering Laboratory at the University of Michigan, by G. V. Edmonson

**59—Hyd-17** Unsteady Transfer of Momentum and Heat Between Concentric Cylinders, by Chia-Shun Yih

**59 Hyd-18** Discharge Coefficients and Steady-State Flow Forces for Hydraulic Poppet Valves, by J. A. Stone

**59—Hyd-19** Firmoviscous and Anelastic Properties of Fluids and Their Effects on the Propagation of Compression Waves, by F. D. Ezekiel and H. M. Paynter

**59—Hyd-20** Design and Test of Mixed-Flow and Centrifugal Impellers, by J. J. Kramer, W. M. Osborn, and J. T. Hamrick

Authors of technical papers, *left to right:* John S. Worth, Mem. ASME, Bethlehem Steel Company; S. Donald Stookey, Corning Glass Works; M. E. Shank, Mem. ASME, M.I.T.; George R. Irwin, U. S. Naval Research Laboratory

Head-table group at Dinner: W. E. Cooper; ASME President Glenn B. Warren; Toastmaster Richard G. Folsom; M. J. Manjoine

N. J. Grant of M.I.T., the luncheon speaker

# What Causes Failure in Metals?

## *First ASME Metals Engineering Conference hears reports on research advances and new applications*

TECHNICAL presentations at the First National Metals Engineering Conference were concerned primarily with various failure mechanisms in metals. Actually the range, as described by John J. B. Rutherford, was from "solid-state physics to metals in heavy section, including nonmetallic materials." Mr. Rutherford, Mem. ASME and chairman of the opening session, is with the Tubular Products Division of The Babcock & Wilcox Company, Beaver Falls, Pa.

The three-day conference of The American Society of Mechanical Engineers Metals Engineering Division was held at the Sheraton Ten-Eyck Hotel, Albany, N. Y., April 29–May 1, 1959, and had an attendance of 236.

### President Warren Dinner Speaker

ASME President Glenn B. Warren was the speaker at the conference Dinner and Richard G. Folsom, a director of ASME, was the toastmaster. President Warren, whose topic was "Metallurgy and the Engineer," stated that in general, the mechanical engineer has always built up to and even beyond the limits of his materials. With the recent acceleration of technical progress, the design engineer is presenting daily challenges to the materials engineer. This need for new materials can be grouped into four categories: (*a*) Increased reliability, (*b*) increased power range, (*c*) lower cost, (*d*) innovations previously impossible. Low cost is rarely achieved in the initial design phases and must be sought by redesigning again and again. Most great revolutionary innovations in the past have been the work of one man, usually under 45, and more often than not, working outside his own field. Today, most innovations are planned and their realization is usually the result of work by assigned teams.

Mr. Warren said that the progress in the field of materials could be summed up under general trends, a search for specific properties, and concentration on areas which need greater common understanding. He commented on the simultaneous emphasis on enlargement and miniaturization, particularly noticeable in missile development. There has been a change of one order of magnitude in the past century and we are on the verge of another, as witnessed by the thin films for magnetic storage on the one hand and 500-ton open-hearth and forging ingots on the other. Sophistication of design has been a major factor in materials progress; temperature requirements, grain-size control, and ultrahigh purity have been others. Materials are currently needed with stability at both solar and gas-liquefaction temperatures, and the trend to increasing complexity of materials requirements is growing exponentially.

There has also been a major overhaul of processing, compacting, and consolidating methods, with the attainment of standards of purity never even conceived using traditional techniques, Mr. Warren said. Many of these processes are now carried out without passing the material through a molten stage.

While outlining a number of specific needs in the materials field (some of which are included in his article in MECHANICAL ENGINEERING, May, 1959, pp. 40–42), he stressed that, in the words of Owen D. Young: "Our greatest assets are the things we don't yet know." Innovation is needed in the solution of most of the world's pressing problems and criticism will play a vital role.

Criticism is the means by which we sort out impractical ideas, but new ideas have frequently been delayed two to 20 years by unfavorable criticism and stubborn opposition from those whose responsibility it would be to put them into effect. We could more than double the rate of successful innovations brought to practice in all areas, Mr. Warren stated, if we would greet each new idea with an open mind and think of the potential places it could advantageously be applied. Application is the important test, not the number of new ideas. We need to pump these innovations full of life rather than yield too readily to the instinct which most of us have to say that they won't work.

### Materials Development

N. J. Grant of M. I. T. was the speaker at the luncheon, and James F. Young, Mem. ASME, general manager of General Electric's General Engineering Laboratory, was toastmaster. Professor Grant stated that the development of materials since 1940 has been "astounding." Not only metallics, but ceramics, lubricants, fuels, and plastics have all shown remarkable progress. At one time the metallurgist alone was sufficient for material development but the problem is now more complex. Metal-plus-glass, metal-plus-plastic, and glass-reinforced plastic materials are being used. For further progress, disciplines will have to be crossed, and an interplay maintained between scientific achievement, engineering achievement, and industrial development.

Plastics have now become structural materials, and Professor Grant described a pavilion being built in Russia entirely of plastics with 14-in-thick columns and a $^1/_{16}$-in-thick dome. It can withstand 60-mph winds and 3000-psi loads, has an elastic modulus of 1 million psi and is temperature resistant.

In reply to a question on the progress of engineering in Russia, Professor Grant stated that there is a great deal of effort, "much of it junk." Some of the poor quality is the result of a lack of "weeding," and an emphasis on publication. He estimated that three to four times as many people were involved in research in Russia as in the U. S., and

that even with inferior results it would take only twice as many to exceed our progress in time. He stated that the atmosphere for research was good and the facilities were good, but crowded.

### Technical Sessions

The technical program, which consisted of sessions of related papers devoted to particular topics, was introduced with two general papers on the nature of plastic flow and fracture and some of the engineering aspects of these mechanisms. Other sessions dealt with brittle fracture, creep behavior, fatigue, and high-temperature behavior of metals. There was also a workshop on the application of metals in heavy sections.

In line with repeated suggestions that reports of ASME research activities be included in division conferences, one session was devoted to subcommittee reports by members of the ASME Research Committee on the Prevention of Fracture in Metals.

### Research Reports

Jack D. Lubahn, Mem. ASME, chairman, Subcommittee on Notch Sensitivity of Knolls Atomic Power Laboratory, stated that in spite of the largely empirical solution of the problems of ship, landing-gear, turbine-rotor, and missile-fuel-tank failures from brittle fracture, the problem was still poorly understood. The greatest contributions have been the "energy" concepts, particularly of Griffith and Irwin. Tests of stresses for mild plate and large forgings have been made, but the connection between test results is not apparent. A wider range of tests and the evaluation of available concepts with analytical work are badly needed and are the basis of the subcommittee's research plans. Broader concepts which can serve as a basis for design are the goal.

M. J. Manjoine, Mem. ASME, chairman, Subcommittee on High Temperature Combined Stress, of Westinghouse Research Laboratories, reported that the correlation of the influence of combined stresses at elevated temperatures with uniaxial tests was the major interest of the subcommittee. More information is needed. A method of relating the triaxiality factor to ductility would help in predicting failure. Although the criteria for flow are well known, and it is known that fracture is preceded by first, second, and third stage creep, it is still not known *when* fracture will initiate.

K. R. Merckx, Mem. ASME, chairman, Subcommittee on Low-Cycle Fatigue, of the Hanford Laboratories, said that most fatigue tests have concentrated on the 10,000 or 100,000-cycle range, but there are increasing failures with as few as 10 or a hundred cycles. The committee will attempt, in a long-range program, to determine the: (*a*) Correlation between uniaxial and multiaxial strain cycling, (*b*) effects of mean stress upon strain-cycling or thermal-cycling tests, (*c*) correlation of various strain-concentration factors with those predicted by elastic analysis, (*d*) effect of varying the cycle-repetition time, (*e*) damage criteria, in order to establish cumulative design criteria.

The lack of firm theory in many areas and the need for research were apparent in the discussions which followed many of the technical papers. Authors frequently disagreed on the proper method of solution and there was some difficulty over differences in terminology.

Another research report was given by John J. Worth of Bethlehem Steel, Mem. ASME, and member of the ASME-ASTM Joint Committee on the Effect of Temperature on the Properties of Metals. He reported on Project SP-4 of the Steam Power Panel. The project determined the high-temperature properties of ASTM A 212 Grade B plate to permit substitution for A 201 Grade B in order to reduce weight in exports under International Organization for Standardization requirements.

One session of the conference was on nonmetallic structural materials. Papers were given on ceramics for advanced engineering applications and on the fabrication and properties of Pyroceram. Some specific applications were included in the survey of "nonmetallic inorganic materials" included in the first paper. Among them was a ceramic corrugated material for possible use in heat-exchange applications. Whisker composites are being studied on the ceramic area and offer an opportunity for major improvements in the strength of materials.

Pyroceram, most widely publicized for its missile-nose-cone use, is a radically new material whose possible applications are just being explored. It will be many years before the properties are as well known as those of metals, according to the author. Although Pyroceram is a white crystalline material, it will take a high polish, and one application is for optical mirrors which do not distort with changes in temperature.

In addition to the papers dealing with specific design solutions and materials tests, there were theoretical papers on such topics as "Fracture Mode Transition for a Crack Traversing a Plate," "A Unified Interpretation of Room-Temperature Strength of Notched Specimens as Influenced by Their Size," and on the measurement of plastic strains with the use of the moiré effect.

The panel on the application of metals in heavy sections stressed the need for co-operation between the user and the producer, particularly in the area of specifications. If the best design solution is to be achieved, the purchaser's specifications should not be too restrictive or confined solely to well-known materials.

Much of the credit for the success of the Division's first conference was given to the Conference Committee and the enthusiastic co-operation of the Hudson-Mohawk Section.

## Availability List—Metals Engineering Conference

THE papers in this list are available in separate copy form until Feb. 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

**59—Met-1** A Generalization of Cumulative Damage, by R. M. Mains

**59—Met-2** Relations Between the Notch Tensile Strength of Cylindrical and Prismatic Specimens of Titanium Alloys and Heat-Treated Steels, by G. Sachs, J. G. Sessler, R. F. Pray, and T. H. Yeh

**59—Met-3** Effect of Relaxation on the Behavior of Materials Under Combined Alternating and Static Stress, by F. H. Vitovec

**59—Met-4** Cyclic Operation of Pressure Piping With $\gamma$ Heating, by K. R. Merckx

**59—Met-5** Steady Creep of a Tube Under Combined Bending and Internal Pressure, by Iain Finnie

**59—Met-6** Report of Anomalous "Brittle" Failures of Heavy Steel Forgings at Elevated Temperatures, by A. J. Babecki, P. P. Puzak, and W. S. Pellini

**59—Met-7** Use of the Moiré Effect to Measure Plastic Strains, by A. Vinckier and R. Dechaene

**59—Met-8** Design of Pressurized Cylinders for High-Temperature Applications, by J. F. Traexler

**59—Met-9** A Unified Interpretation of Room Temperature Strength of Notched Specimens as Influenced by Their Size, by B. M. Wundt

**59—Met-10** Nonmetallic Inclusions and Fracture Behavior of Steels, by S. Yukawa

**59—Met-11** Effect of Wall Thickness on Stress-Rupture Life of Tubular Specimens, by J. T. Tucker, Jr., E. E. Coulter, and L. F. Kooistra

**59—Met-12** Report of Project SP-4 to Steam Power Panel of the ASME-ASTM Joint Committee on the Effect of Temperature on the Properties of Metals, by J. S. Worth

**59—Met-13** Notch Rupture Strength of Type 347 Heat Affected Zone, by R. J. Christoffel

**59—Met-14** Creep Rupture Tests for Design of High-Pressure Steam Equipment, by E. A. Davis

# ASME-SAM Work Smarter not Harder . . .

## . . . at Management Engineering Conference, April 23-24, 1959, Hotel Statler, New York City

At the 14th Annual Management Engineering Conference held jointly with the Society for Advancement of Management, the ASME Management Division sought to fulfill its objectives: To improve management by the application of engineering science and the engineering point of view, to serve the management interests of: ASME members who are interested in learning management techniques and improving their management abilities; managers of engineering functions; engineers in general management; engineers of management, who are concerned with the development and application of management skills and knowledge; and colleges and universities engaged in developing engineers for management. These are the objectives of the ASME Management Division.[1] The conference theme was "Profitable Management Engineering" and was held April 23-24, 1959, at the Statler Hilton Hotel, New York, N. Y.

Technical papers, 16 in all, were designed to bring up to date the vast amount of theory and practice which business and industry can use to improve their current operations and to uncover new possibilities of profit improvement.

Such areas of management science as work sampling, work simplification, quality control, and the use of computers in the solution of complex management problems were explored. The basic themes of all such studies were: Practical cost reduction, improving management productivity, new approaches in using and maintaining standards, and optimizing the solution of production control problems.

The human side of management was analyzed in relation to personal development of industrial engineers as well as in relation to the role of labor in productivity, and the question of incentives.

### "Work Smarter Not Harder"

"A creative worker is, or can be, any employee in [an] organization," according to Chester L. Brisley, staff assistant to director of production, Chance Vought Aircraft, Inc., Dallas, Texas. Dr. Brisley's concern was, however, with those personnel who, by virtue of their unique training and experience, are performing creative tasks—engineers, planners, designers. It is his contention that the more fully such persons can concentrate on their creative talents by eliminating menial tasks, the happier and better satisfied they will be. Consequently, his value to the company is enhanced. Dr. Brisley described work sampling studies which bear this out.

### Man to Manager

ASME President, Glenn B. Warren, in a luncheon address, expounded further on "The ASME Interest in Management Science." Mr. Warren stated that ". . . . the ASME and other technical professional engineering societies need to improve the management proficiency of the large number of their members who get into the top or near top management posts of business, and similarly of those engineers who are concerned with the management of complex government and defense projects which require technical understanding, if not proficiency, to permit their making of proper management decisions in these increasingly vital areas."

How to achieve this? Mr. Warren suggests that the Society continue to or seek to find the management science areas in which sufficiently exact knowledge does not yet exist, or which are as yet controversial, and then set up exact knowledge or new and original clarification. Also he recommended that the use of new computational and mathematical techniques be encouraged, together with the increasing availability of statistical material, to predict results. As in operational research, varying specific business, governmental, or financial practices could aid in predicting over-all or specific industrial and economic activity and well-being. It is important, too, that the Society cooperate with and augment the results of other groups working in these same basic areas.

That co-operation was manifested throughout the conference by the presence of top engineers and top management as well as leading educators in both fields.

### Manager to Man

Phil Carroll, Fellow ASME and SAM President, spoke of "SAM's Contribution to Management Education." He pointed to the many opportunities for self-development offered by SAM and other professional societies.

Acquaintance with men in different areas of business and industry permits a better informed choice of goals. Such a choice makes the difference between "positive drive and indecisive drift."

Repeated exposures to all phases of management give the individual an advantage when making a choice in plan-

[1] Mechanical Engineering, March, 1959, p. 71.

**Presentation of Material Handling Award. H. H. Hall, Mem. ASME, *left,* recipient; Warren J. King, SAM vice-president for material handling.**

**Presentation of Industrial Incentive Award. Arthur Rath, *left,* recipient; Phil Carroll, Fellow ASME and SAM President.**

**Presentation of Gilbreth Award. Gerald B. Bailey, *left,* recipient; Phil Carroll. Awards presented during ASME Management-SAM Conference.**

ning his career between line and staff work.

Work on a local level of a society provides opportunities for one who otherwise could not exercise his managerial potential.

Another advantage, one not often considered a benefit of professional society activity, but nonetheless significant, is the opportunity to acquire skill with words. One of the manager's chief functions is communication. Discussions, presentation of papers, the making of announcements—all afford superior opportunities for proficiency in this area.

Finally, there is the advantage most often placed first. That is the opportunity to supplement old knowledge and gain new knowledge through attendance at meetings and conferences.

### Man to Man

"....Most of us want to do what is right....our mistakes in human relations are not caused by intent to do wrong." This is the thesis set forth by Louis E. Newman, Mem. ASME, in a luncheon talk, "The Human Side of Managing." Mr. Newman suggested that management's intentions are often distorted by the methods with which they are carried out. He offered ten practical principles as guides to avoiding such pitfalls. Among them are: Let management's good intentions be recognized; use low-pressure persuasion; give employees a feeling of participation; exchange short-term satisfaction for long-term values.

### First Step the Hardest

Perhaps the dominant note of the conference was expressed by Dr. Brisley in a quotation from a monthly letter published by the Royal Bank of Canada:

> **"Every method we use in production of goods, in distribution, and in selling, was at some time or other new to the world. To put them into use, there had to be daring men and women, people who saw visions and attacked problems with ferocious determination."**

# Second Maintenance and Plant Engineering Conference Held in Chicago

The second annual National Conference on Maintenance and Plant Engineering was held at the Edgewater Beach Hotel, Chicago, Ill., May 4-5, 1959. The conference was sponsored by the Maintenance and Plant Engineering Division of The American Society of Mechanical Engineers in co-operation with the Chicago Section and with participation by the American Institute of Plant Engineers. There was an attendance of 124.

ASME President Glenn B. Warren delivered the Banquet Address on "The Importance of High-Level Maintenance and Plant Engineering." M. V. Maxwell, Mem. ASME, chairman of the Chicago Section, presided. Richard S. Falk, assistant to the president and secretary, The Falk Corporation, Milwaukee, Wis., spoke on "General Management Views the Plant Engineering Department," at the luncheon, and S. A. Simonson, president of the American Institute of Plant Engineers, presided.

Five technical papers, all of which were preprinted, were presented at the two technical sessions on the techniques and management aspects of maintenance.

### Maintenance—Outdoors

Methods for the efficient sandblasting of steel surfaces were surveyed at the first session. A comparison of types of equipment and relative costs for this important method of surface preparation were given. Protective coatings were the topic of another paper on the practical aspects of developing realistic coating specifications that can be met with practical methods, equipment, and materials at reasonable cost. The author's company has developed more than 100 pages of standard specifications for surface preparation, coating systems, materials, and inspection and safety procedures which permit brief job specifications since they are supported by the detailed standards. Over-all painting costs and corrosion losses have been reduced and a simple nondestructive method for measuring dry-film thickness over corners, irregular surfaces, and specialized materials is being sought. Maintenance of parking lots and grounds was the topic of the other paper. It included practical methods for the patching of pavements and other problems ranging as far as the control of weeds and insect pests in lawns and shrubs.

### Plant Engineering

The second session dealt with some management techniques for achieving good maintenance. Good preventive maintenance was described as beginning with the selection of equipment for purchase. Desirable design features which will facilitate maintenance can then be specified and the purchase of equipment which has given maintenance difficulties in the past can be avoided. Standard practices, equipment checks, records, reference print files, and organization all have a part in the preventive-maintenance program.

The central job shop, which was the topic of the other paper, has an important part in providing the tools and special skills which cannot be duplicated in individual maintenance areas. The cost of providing various services must always be balanced against the cost of purchasing these from an outside company. The advantages of craft and functional organization, or a combination of the two, were compared and the part played by job classification was discussed. Tools and layout, work measurement, and scheduling were also related to the overall problem.

The third session was a forum on maintenance with a panel of four speakers. K. P. Powers, Mem. ASME, of Gulf Research and Development Company, was session chairman and also served as moderator.

The conference also included an inspection trip to the Chicago North Side Filtration Facility which, in 1955, was named by ASCE as one of the Seven Modern Civil Engineering Wonders in the U.S., and faces many of the maintenance problems found in an industrial plant. The $100-million facility will deliver 960 mgd of water to the 3 million people of Chicago's north side and suburbs and will have an ultimate capacity of 1680 mgd.

## Availability List—Maintenance and Plant Engineering

The papers in this list are available in separate copy form until March 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

**59—MPE-1** The Technique of Efficient Sandblasting, by P. E. Weaver

**59—MPE-2** The Role of a Central Job Ship in Area Maintenance, by C. H. Harker

**59—MPE-3** Practical Aspects of Protective-Coating Specifications, by J. R. Allen and G. Mackey

**59—MPE-4** Maintenance of Parking Lots and Grounds, by A. K. Carter

**59—MPE-5** Engineering for Good Preventive Maintenance, by E. R. Schauffele and H. W. Parsons

Conducted for the National Junior Committee
A. S. GOLDSTEIN

# JUNIOR FORUM

## The Role of the Mechanical Engineer in the Infrared Field

By K. W. Harper[2]

THE purpose of this article is to describe areas in the infrared (IR) field where mechanical engineers may find successful and rewarding careers. The development of infrared for both military and commercial application received impetus during World War II. The history of infrared dates back to 1800 when Sir William Herschel, the famous astronomer, coined the phrase "invisible light." The term infrared is used to refer to the portion of the electromagnetic spectrum between the visible region and the microwave region.

All objects at a temperature above absolute zero emit infrared radiation. This radiation increases as the fourth power of the absolute temperature. The temperature of such items as rocket motors, jet engines, and furnaces makes them suitable for infrared radiation.

In order to make use of IR radiation, properly designed equipment which require the services of mechanical engineers are needed. An optical or collector system, suitable detection devices, and proper auxiliary equipment are all necessary in using IR radiation. At the present time, the use of IR for detection is drawing the most attention and poses many challenges for the young mechanical engineer. The IR field occupies the same position that radar did at the beginning of World War II. Extensive development is required in the areas of optics, mechanics (precision in most cases), detectors, and cryogenics (low-temperature applications), all of which must be combined and packaged.

This equipment must be developed and designed to operate in extreme environmental conditions.

The potential of infrared utilization is unlimited, and many new applications will be evolved during the coming era of technological progress. Infrared principles are used in the following:

**Spectrometry (identification of chemical compounds)**
**Detection (missiles and objects in space)**
**Photography (infrared film)**
**Space navigation**
**Weather forecasting**
**Stabilization of space vehicles**
**Astronomy**
**Process-control applications**
**Pyrometry**
**Fire-control systems**

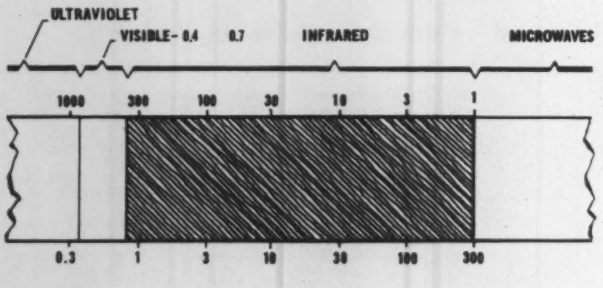
Some difficult mechanical-engineering problems are described in the following. All of these areas offer interesting work and opportunities for young engineers.

***1 Optical Material.*** Infrared energy is similar to light energy. It is dispersed in all directions and therefore must be received and collected by a telescopic or optical system so that it can be focused on a detector. The optical system must be specially designed to withstand shock, vibration, and extreme environmental conditions. The optical system consists of special materials used as lenses and contains moving parts, all of which must be arranged and mounted in specified relationships which cannot change under operating conditions. Any shift of one part in respect to other parts in the system will seriously affect the optical adjustment and hamper the performance of the equipment. In this area the mechanical engineer must apply his knowledge of materials, structures, and kinematics.

***2 Detectors and Cryogenics.*** The detector receives the energy collected by the optical system and generates a signal which is used in the electronic sections of IR equipment. These detectors consist of special sensitive materials which must operate at temperatures below −300 F, and down to the temperatures of liquid nitrogen and helium. This presents the challenge of mounting, insulating, and cooling the detectors. There are two commercially available liquid low-pressure nitrogen storage and supply systems, and a few high-pressure gaseous systems which require supercooling of the nitrogen to obtain the extremely low temperatures. The low-pressure systems are limited in operating time and the high-pressure systems are heavy and require greater space. Here is an area where the mechanical engineer will encounter many challenges. At the present time there is a requirement for a small lightweight enclosed compressor-

[1] Engineering writer, General Electric Advanced Electronics Center at Cornell University, Ithaca, N. Y. Assoc. Mem. ASME.

[2] Consulting engineer, General Electric Advanced Electronics Center, Light Military Electronics Department, Ithaca, N. Y. Mem. ASME.




### Chairman's Corner

ONE of the main themes of Junior Forum is the publishing of articles which describe possible career areas for young engineers. If you would like to see an article pertaining to some particular field, let us know. If you would like to write an article about the opportunities for young engineers in some field, we would be glad to receive and publish it.

This material should be sent to:

A. S. Goldstein, Chairman
Junior Forum Subcommittee
National Junior Committee
Advanced Electronics Center
General Electric Company
Ithaca, New York

type system using nitrogen. There is no satisfactory system available to meet the required specifications. In addition, methods of handling liquid helium (about −454 F) have to be developed along with a system using helium as a cooling medium.

***3 Tracking Systems.*** Tracking systems is an area in which a great deal of precision mechanical design work can be accomplished. The tracker must be aimed and controlled by servomotors, so that it will track a moving target, even though the tracker and the tracker mount moves. The tracker is usually mounted on gimbals and its position is controlled by a servo or servotorque motor. A feedback signal from the processing reticle of the optical system controls the motors. This control must be precisely designed and it must also have the lowest moment of inertia and the best balance possible. The use of lightweight materials and placing of the components to obtain a delicate balance is a prerequisite in tracking systems. The use of precision shaft angle encoders is necessary in many systems to read out the precise position of aiming of the tracker. This angle encoder is sometimes as precise as 0.1 mil.

The mechanical engineer can do a splendid job in placing these various units in the most strategic and efficient places, keeping in mind that simplicity is one of the most important ingredients in precision equipment.

The infrared field is a combination of physics and engineering. It requires the services of many types of engineers and scientists and offers challenges in many fields. The practical use of infrared is still in the pioneer stage, and in the opinion of many it has a "bright red future."

**Walker Cisler, Fellow ASME, chairman of Hoover Medal Board of Award, presents Medal to Lieut. Gen. R. A. Wheeler, 19th recipient of award at Society of American Military Engineers dinner, Mayflower Hotel, Washington, D. C., February 19**

## ASME COMING EVENTS

**June 1–3**

ASME Boiler and Pressure Vessel Committee Out-of-Town Meeting, Palliser Hotel, Calgary, Alberta, Canada.

**June 8–12**

ASME, AMHS, SAM Materials Handling Conference, Cleveland Auditorium, Cleveland, Ohio

**June 14–18**

ASME Semi-Annual Meeting, Chase, Park Plaza Hotels, St. Louis, Mo.

**June 18–20**

ASME Applied Mechanics Conference, Rensselaer Polytechnic Institute, Troy, N. Y.

**August 9–12**

ASME-AIChE Heat Transfer Conference, University of Connecticut, Storrs, Conn.

**September 9–11**

ASME Applied Mechanics Western Conference, Stanford University, Stanford, Calif.

**September 10–12**

ASMF, AIChE, FPRS Wood Industries Conference, Multnomah Hotel, Portland, Ore.

**September 17–18**

ASME-AIEE Engineering Management Conference, Statler Hilton Hotel, Los Angeles, Calif.

**September 20–23**

ASME Petroleum Mechanical Engineering Conference, Rice Hotel, Houston, Texas

**September 27–October 1**

ASME-AIEE National Power Conference, Hotel Muehlebach, Kansas City, Mo.

**October 20–22**

ASME-ASLE Lubrication Conference, Hotel Sheraton-McAlpin, New York, N. Y.

**October 26–29**

ASME-AIME Fuels Conference, Netherland Hilton Hotel, Cincinnati, Ohio

**November 4–6**

ASME-IRE-AIEE-ISA National Automatic Control Conference, Sheraton Hotel, Dallas, Texas

**November 8–13**

ASME, ASTM, ACS International Rubber Conference, Shoreham and Park Plaza Hotels, Washington, D. C.

**November 16–20**

ASME Materials Handling Conference, New York Trade Show Building, New York, N. Y.

**November 29–December 4**

ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

*(For Meetings of Other Societies, see page 119)*

NOTE: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for which there is no charge providing you state that you are a member of ASME.

## Notice—ASME Applied Mechanics Conference Relocated

DUE to reasons beyond the control of Virginia Polytechnic Institute, the 22nd Applied Mechanics Division National Conference has been relocated and now will be held in Lecture Hall, Russell Sage Laboratory, at Rensselaer Polytechnic Institute, Troy, N. Y., June 18–20, 1959.

# Woman's Auxiliary to ASME Aids Students

THE Woman's Auxiliary to the ASME annually awards scholarships and Student Loans to worthy students of mechanical engineering.

The task of the Scholarship Committees is difficult. It requires wisdom and judgment to choose from the many applicants of merit those few most worthy recipients.

### Sylvia W. Farny Scholarship

This year the Sylvia W. Farny Scholarship Committee chose four recipients of $500 scholarships: Peter Bizon, Robert J. Raymond, Ross L. Goble, and Edward J. Duin.

Peter Bizon, a 20-year old student at the University of Pittsburgh, holds office in Pi Tau Sigma and Sigma Tau. He is active in several functions and is on the staff of the school's engineering publication. Last year he received a citation of the American Society of Military Engineers for outstanding AFROTC cadet service.

Robert J. Raymond, honor student and top man in his class at the Massachusetts Institute of Technology, is 21 years old. Mr. Raymond is also a student technician in an M.I.T. laboratory.

Ross L. Goble, a 27-year old student at Clemson College, S. C., is married and has two children. Since entering Clemson, he has maintained a straight A average. He has been elected president of the local ASME Student Section, and holds membership in an honorary engineering society.

Edward J. Duin ranks 13 in his class of 301 at North Dakota State College. Mr. Duin is 22 years old. He is a member of Tau Beta Pi, Pi Tau Sigma, and the ASME Student Section at his school.

The Committee and the National Board wish to express their sincere appreciation to the various Sections for their generous support and contributions to this fund in the past, and hope you will be inspired not only to continue but also to increase your gifts to these funds. Help contribute to the mechanical engineer of tomorrow.

Committee members are: Mmes. Crosby Field, Maurice Weschler, William H. Larkin, Arthur M. Gompf, and Ralph L. Goetzenberger, chairman.

### Marjorie R. Rothermel Fund

The Marjorie Roy Rothermel Scholarship Fund was established in memory of Mrs. Rothermel who died Nov. 13, 1957, while serving as the 21st president of the Woman's Auxiliary to the ASME.

The fund provides for at least one scholarship of $750 to be conferred annually. A candidate must be a man or woman citizen of the United States, who is in his senior year in mechanical engineering or who has already received a Bachelor's Degree in mechanical engineering at an accredited U. S. college or university, and who desires to continue his study for an advanced degree in engineering. The candidate must hold some grade of ASME membership. Selection is based on character, scholastic achievement, and financial need.

Information concerning this scholarship and application forms will be available in schools offering graduate courses in engineering. Applications are to be submitted to the Committee by

## ARS-ASME Affiliation

*Reports on Benefits of Affiliation*

THE affiliation existing between The American Society of Mechanical Engineers and the American Rocket Society offers the membership of both societies a broad spectrum of scientific and engineering activities.

Mutual co-operation is effected through an ASME-ARS Joint Committee and through representation of each Society on the appropriate governing body of the other.

The advantages to the membership of each Society of this affiliation include the following:

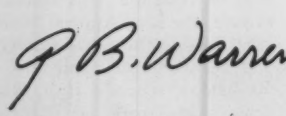
(*a*) Joint meetings at which the complete program of each Society is open to the membership of the other Society.

(*b*) Co-ordination of technical program planning through co-operation of professional divisions of the two Societies so that the interests of the members of both Societies may be better served.

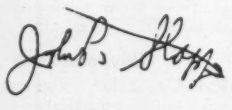
(*c*) A member of one of the two Societies may become a member of the other without payment of initiation or entrance fees in the second Society, provided he can qualify for membership in the second Society.

(*d*) Members of each Society are extended the privilege of purchasing publications of the other Society at the members' rate. The following tabulation shows the existing rates:

| ARS Publications | Nonmembers | Members |
|---|---|---|
| ARS Journal | $12.50 | $ 6.25 |
| Astronautics | 9.00 | 4.50 |
| Technical Papers | .50 | .25 |
| **ASME Publications** | | |
| Applied Mechanics Reviews | 25.00 | 10.00 |
| PMM-Journal of Applied Mathematics and Mechanics | 35.00 | 28.00 |
| MECHANICAL ENGINEERING | 7.00 | 5.60 |
| ASME Transactions (Bound) (1958 Volume and earlier) (Quarterly, beginning January, 1959): | 30.00 | 15.00 |
| Journal of Heat Transfer | 10.00 | 5.00 |
| Journal of Basic Engineering | 10.00 | 5.00 |
| Journal of Engineering for Power | 10.00 | 5.00 |
| Journal of Engineering for Industry | 10.00 | 5.00 |
| Journal of Applied Mechanics | 10.00 | 5.00 |
| Individual technical papers | .80 | .40 |
| Books, Codes and Standards | Various | 20% discount |



Glenn B. Warren, President
The American Society of Mechanical Engineers



John P. Stapp, President
American Rocket Society

February, 1960. Members of the Committee are: Mrs. F. H. Fowler, Jr., Philadelphia, Pa.; Mrs. T. N. Graser, Boston, Mass.; Mrs. E. R. Kaiser; and Mrs. D. V. Minard, Metropolitan Section. Additional information may be obtained from the committee chairman, Mrs. Frank W. Miller, 7805 Cobden Road, Philadelphia, Pa.

### Student Loan Fund

One of the most important funds of the Woman's Auxiliary to the ASME is the Student Loan Fund. Through the fund, many persons who for one reason or another were not eligible for scholarship awards were enabled to finish school. The Loan Fund Committee is untiring in its efforts to select those whom they believe will benefit most from such a loan. They must combine great understanding with great warmth, and yet remain impersonal in their judgment.

A letter from the wife of a loan recipient (father of four children) to the chairman of the fund, Mrs. Walter F. Friend, serves to illustrate not only the gratitude of those who benefited, but also the wisdom of the committee. A portion of that letter follows: "We are enclosing a check for the balance due on our loan. Words cannot properly express our gratitude. The money was enough to permit my husband to finish school; but, more important, . . . was the fact that someone actually had the faith which we had that he would finish." The recipient has received an award for being the outstanding mechanical-engineering student at his school in 1957. He has also passed the first half of his examinations for licensed professional engineer in the State of Illinois.

Also available to the deserving student is the Calvin W. Rice Memorial Scholarship Fund, which is a $1500 scholarship, awarded annually toward the expense of one year's graduate study in the United States in mechanical engineering by a foreign student who is brought to the United States and who shall return to his country upon completion of his work. This scholarship is granted in an effort to promote better understanding throughout the world.

We of the Auxiliary, the report pointed out, should feel a sense of fulfillment in aiding the career of a dedicated engineer. Each of our donations could contribute immeasurably toward helping young men and women to achieve their ambitions. The auxiliary certainly deserves the consideration—and help—of the entire membership of the Society.

## ASME Honors Canadian

H. S. Van Patter, vice-president and director of Dominion Engineering Works Limited, Montreal, Que., Canada, recently has been elected to the grade of Fellow of The American Society of Mechanical Engineers. He has been a member of ASME since 1946.

To mark the occasion a luncheon was held at the University Club, Montreal, on April 22, with Dr. R. E. Heartz, Hon. Mem. ASME, in the chair. Dr. L. Austin Wright, Mem. ASME, presented Mr. Van Patter to the meeting and outlined his long connection and many activities with the Engineering Institute of Canada.

S. Logan Kerr, Fellow ASME, gave a short account of Mr. Van Patter's accomplishments in the field of engineering and of administration, pointing out that during the period of his services with the Dominion Engineering Works as design engineer and administrator the company has produced 13.5 million hp of hydraulic turbines. He referred also to the valuable experimental work done by Mr. Van Patter on turbines, pumps, and cavitation.

Dr. Heartz then presented the certificate of Fellowship to Mr. Van Patter, making reference to the many satisfactory transactions he had had with Mr. Van Patter and his company.

In response, Mr. Van Patter disclaimed the credit for the many achievements which had been mentioned by the three speakers. He gave credit for all of these to the company and to the many excellent people who had been associated with him throughout his almost 40 years of connection with the Dominion Engineering Works Limited.

In conclusion, the meeting expressed to Dr. Heartz its appreciation of his thoughtfulness in bringing the group together to mark this interesting occasion.

**Dr. R. E. Heartz, *right*, presents certificate of Fellow grade in ASME to H. S. Van Patter, *center*, as S. Logan Kerr looks on. The presentation was made at a luncheon held in Mr. Van Patter's honor at University Club, Montreal, April 22.**

## ACTIONS ASME EXECUTIVE COMMITTEE

A meeting of the Executive Committee of the Council of The American Society of Mechanical Engineers was held in the rooms of the Society on Friday, March 6, 1959. There were present: G. B. Warren, Chairman; E. W. Allardt, L. N. Rowley, and A. W. Weber of the Executive Committee; E. G. Bailey and W. F. Ryan, past-presidents; V. W. Smith, a director; E. J. Kates, treasurer; H. J. Bauer, assistant treasurer; L. C. Smith, Organization Committee chairman; W. H. Larkin, ASME Representative to ECPD; O. B. Schier, II, secretary; W. E. Letroadec, W. E. Reaser, and J. D. Wilding, assistant secretaries; J. J. Jaklitsch, Jr., editor; H. I. Nagorsky, controller; and D. B. MacDougall, associate head, Field Service.

The following actions of the Council are of general interest.

***ASME Group Life Insurance.*** On recommendation of the Pension Committee the Council voted to increase the present top limit of coverage of the present group life insurance policies for ASME staff from $6000 to $10,000.

***References for Transfer From Associate Member to Member.*** The Board on Membership recommended to the Council that only two Member or Fellow references be required for transfer from Associate Member to Member. Board's reasoning: To promote and assist qualified Associate

Members to transfer to the Member grade. The Board also pointed out that when a man applies for the grade of Associate Member he is required to have three references, at least one of whom shall be a Fellow, Member, or Affiliate. By having only two Member or Fellow references when transferring to the grade of Member, he would have on file a total of five references, three of whom would be Fellows, Members, or Affiliates, as now required by Article R4, Rule 1. The Council voted to accept the Board's recommendation and to refer the matter to the Constitution and By-Laws Committee.

***Reinstatements.*** On recommendation of the Board on Membership, the Council voted to authorize the chairman of the Membership Review Committee to recommend monthly to the Council reinstatements in the same grade of membership as formerly held within three years of lapse of membership.

***Sections.*** Fifty paid-up members of the present Paducah Group of the Louisville Section have petitioned for Subsection status. Upon recommendation of Vice-President Dolan, Region VI, and approval of the Louisville Section, the Council authorized the formation of the Paducah Subsection of the Louisville Section, having the same territory and headquarters city as the present Paducah Group of the Louisville Section.

***ASME Insignia.*** The Council granted the Johns Hopkins Engineers permission to use the ASME clover leaf emblem on the bronze plaque commemorating the fund established to honor professors of The Johns Hopkins University who have reached the age of retirement.

***Engineers Joint Council—Proposed Advertising Campaign.*** The EJC Board of Directors has authorized its Public Relations Committee to plan and carry out a public service advertising program to eliminate public confusion over the role of the engineer. To meet the specific expenses of space rates, the EJC Public Relations Committee requested each of EJC's member societies to make a voluntary contribution for this specific purpose. The amount sought for the advertising program is $2500. The Council voted: (1) To approve the proposed advertising campaign of the EJC Public Relations Committee; and (2) to contribute $500 toward this purpose.

***United Engineering Center—Re-Issue of Pledge Cards.*** The normal changes of membership due to transfer, additions, and deletions has prompted several of the larger Sections to request a new set of Member Gifts Campaign Pledge cards with the current addresses of the members in their area. The Council voted to authorize the printing and addressing of a new set of pledge cards for distribution.

***Woman's Auxiliary to the ASME.*** The Woman's Auxiliary to the ASME has pledged the sum of $1000 to the United Engineering Center to be paid over a three-year period. The Council acknowledged the gift from the Woman's Auxiliary with sincere appreciation.

***Certificates of Award.*** As a result of a revised policy on Certificates of Award, the Council delegated to the respective Vice-Presidents its authority to confer an appropriate Certificate of Award on those Section Member Gifts Campaign Chairmen who succeed in obtaining contributions from 50 per cent or more of their members or who have attained 100 per cent of their quotas.

The Council granted Certificates of Award to the following:

Retiring Section Chairmen: Robert D. Charette, New London; Richard H. Meyers, Rock River Valley; Edward W. DeJon, South Texas; George H. Billman, Erie; Frederick K. Sutter, Westmoreland; E. S. Howarth, Pittsburgh; David F. Quan, Ontario; Robert M. Kuhns, San Diego; Ernest W. Weaver, Jr., Toledo; Peter H. Valentyne, Saginaw Valley Subsection of the Detroit Section.

Retiring Professional Division Chairman: Ernest L. Dahlund, Oil and Gas Power Division in 1958.

Member Gifts Campaign Chairmen: Lester L. Bosch, Cincinnati; Robert Cornish, Canton-Alliance-Massillon; Earl Cutter, Dayton; and Benjamin King, West Virginia.

***Past Section Chairmen.*** The Council granted Certificates of Award to the following past-chairmen of Sections: Gale Erwin Nevill, South Texas, 1952–1953; and Richard H. Meleney, San Diego, 1956–1957.

***Appointments.*** The Council appointed A. A. Potter to a three-year term on the Charles Franklin Kettering Board of Award.

Upon recommendation of Vice-President Weber, Region III, the following members were appointed to represent the Society at the Annual Meeting of The American Academy of Political and Social Science, April 10 and 11, 1959, in Philadelphia, Pa., Thomas W. Hopper and W. E. Belcher, Jr.

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A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held in the rooms of the Society on Friday, April 3, 1959. There were present: G. B. Warren, Chairman; E. W. Allardt, L. N. Rowley, and R. B. Smith of the Executive Committee; A. M. Perrin and Joseph Pope, directors; E. J. Kates, treasurer; O. B. Schier, II, secretary; W. E. Letroadec, S. A. Tucker, and J. D. Wilding, assistant secretaries; J. J. Jaklitsch, Jr., editor; H. I. Nagorsky, controller; and D. B. MacDougall, associate head, Field Service.

***Membership Certificate to New Members.*** Because most engineering societies provide new members with a Certificate of Membership at no charge, and in the interest of improving the relation between the members and the Society, the Council, on recommendation of the Board on Membership and the Membership Development Committee, voted that the procedure for notifying ASME members of their election be modernized in part, as follows: Each new member shall receive at no cost, in addition to membership card, book of coupons, and statement of dues, a Certificate of Membership and the Canons of Ethics for Engineers.

***Sections.*** Upon recommendation of Vice-President Harold Grasse, Region VIII, and approval by the South Texas Section of the petition of fifty paid-up members, the Council approved the formation of the San Antonio Subsection of the South Texas Section with headquarters at San Antonio.

Upon recommendation of Vice-President J. W. Little, Region IV, the Council approved the affiliation of the ASME Atlanta Section with the Architects and Engineers Institute, Inc., of Atlanta.

***Student Sections.*** The continuation of the University of Puerto Rico Section, pending accreditation by ECPD, was again reviewed by the Council. The school has requested a postponement of inspection until the fall of 1959 when certain additional physical facilities and some additional changes in the curriculums of the various engineering disciplines will be completed. The Council, therefore, voted to continue the University of Puerto Rico Section and to again review the matter at the ASME Annual Meeting in December, 1959.

***Russian Translations.*** It was reported that on Nov. 1, 1957, the Executive Committee of the Council authorized staff to arrange for the translation of the Russian Journal of Mathematics and Applied Mechanics (PMM) which was subsidized by a grant from the National Science Foundation. ASME has applied for a renewal of the grant for the 1959 edition. Three other translations have been undertaken as follows: (1) Upon recommendation of the Applied Mechanics Division a fundamental book on thin shells will be translated with a grant of $13,500; (2) upon recommendation of the Oil and Gas Power Division a bibliography in the field of sprays with a grant of $5000 is to be printed in Germany; and (3) upon recommendation of the Research Com-

mittee on Friction a translation of a book on friction and wear is being considered. All grants will be requested from the National Science Foundation.

***Nuclear Congress.*** At the request of the Nuclear Congress Operating Committee, the American Society of Civil Engineers has agreed to undertake the management responsibility for the 1960 Congress to be held April 4–9 in New York. W. H. Wisely, executive secretary, ASCE, has asked for an expression of support of the co-operating organizations for this important joint enterprise. The Council voted: (1) To reaffirm the action of the Executive Committee of the Council of Feb. 1, 1958, to support the Nuclear Congresses, under the co-ordination of Engineers Joint Council; and (2) to instruct the ASME Representative to EJC to request that consideration be given to placing the Nuclear Congress on an every-other-year basis, and expressing the hope that the Congress will have the support of the American Nuclear Society and the Atomic Industrial Forum.

***Certificates of Award.*** Certificates of Award were granted to the following:

Retiring Section Chairmen, 1957–1958: Allen Betz, New Orleans; and W. R. Clarke, Mid-Continent.

Member Gifts Campaign Chairmen who have obtained contributions from 50 per cent of their Section membership or 100 per cent of their quota: E. E. Burroughs, Northwest Florida; John D. Melville, Waterbury; Dennison Fairchild, Olean.

***Past Section Chairmen:*** Sydney Ellis, Jr., New Orleans, 1956–1957; John H. Keyes, Sr., Mid-Continent, 1948–1949.

***Died. Warren H. McBryde.*** Fellow and 59th President of the Society died of a stroke on Wednesday, March 25, 1959. The Secretary was directed to express the sincere sympathy of the Council to Mr. McBryde's daughters.

***Appointments.*** President Warren appointed Marshall Anderson to serve a two-year term as ASME representative on the Nominating Committee of CIPM.

## CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after June 25, 1959, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

### New Applications and •Transfers

#### Alabama

•BROWNLEE, JAMES L., 3RD, Birmingham
MIDDLETON, JOHN B., JR., Huntsville

#### Arizona

WOODRUFF, WILLIAM N., Phoenix

#### California

ANDREWS, TEDFORD G., Woodland Hills
•BARLOW, ARTHUR H. F., San Francisco
BLAND, REGINALD B., Laguna Beach
CHRISTOPH, CHRIS K., Hollywood
DONOVAN, RICHARD J., Santa Monica
ELVITSKY, ANATOLE W., San Francisco
GAMBRELL, JAMES B., JR., San Francisco
•HENDERSON, CLARK D., Menlo Park
HENDRICKSON, STANLEY B., La Jolla
•HOLLAND, KENNETH D., JR., Pacific Palisades
IRWIN, JOHN R., Granada Hills
LAUTENBERGER, JOSEPH W., JR., Martinez
MCNIVEN, HUGH D., Berkeley
SHAW, WILLIAM L., Menlo Park
WANTING, PAUL, Alhambra

#### Connecticut

BEAR, MERWYN S., New Britain
CURTIS, WALTER M., Bristol
•HAYDEN, WILLIAM R., Waterbury
•PORZIO, ANTHONY J., Waterbury

#### Delaware

BODEN, FRANK P., Wilmington
DANNENMAIER, JOSEPH H., Newark
MORRIS, JEAN, M., Hockessin
MYERS, WARD R., Wilmington

#### District of Columbia

ANDERS, WILLIAM K., Washington

•Transfer to Member or Affiliate.

#### Florida

ROBESON, EDWARD J., 3RD, Pensacola

#### Georgia

ADAMS, ROBERT B., Atlanta
BOTELER, WINSTON C., Atlanta
ZIBELL, JULES S., Decatur

#### Idaho

BOWES, GERALD R., Idaho Falls
SHEA, JAMES J., Idaho Falls
WOOD, LEE E., Idaho Falls

#### Illinois

BELTON, OLNEY C., Clarendon Hills
DAHLEN, ROBERT N., Chicago
DEMMERT, WILLIAM R., Chicago
HOMER, PERCY A., Loves Park
KASZUBA, RICHARD S., Chicago
NEWLIN, HARRY O., Skokie
•PATTERSON, DWIGHT R., Plainfield
THOMPSON, CARSON E., Chicago

#### Indiana

CHAMBERS, ROBERT A., Fort Wayne
WHITFIELD, ROBERT G., Indianapolis

#### Iowa

MOLIS, EDWARD W., Davenport

#### Kansas

GOWDY, KENNETH K., Manhattan
KINTIGH, JOHN K., Mission

#### Kentucky

DUERR, FRANCIS R., Louisville

#### Louisiana

BECKER, CHARLES P., New Orleans
DASPIT, KENNETH J., Baton Rouge
DAVIES, HARRY R., New Orleans
DAVIS, SAMUEL G., Metairie
•GUILLOT, MALCOLM A., New Orleans
HILLMAN, CARL R., Plaquemine
TRAMMELL, GROVER J., Ruston

#### Maine

ANDERSON, GORDON C., Biddeford

#### Maryland

DISSINGER, RICHARD B., Baltimore
HENDERSON, ROBERT D., Bel Air
LAWSON, THOMAS E., Rockville

#### Massachusetts

ALMEIDA, JOSEPH S. R., Ludlow
DONNELLY, RICHARD A., JR., Boston
GULBRANDSEN, RICHARD E., Beverly
HANLON, FRANCIS E., Somerville
HARLEY, WILLIAM B., Boston
LEGG, LOUIS L., Attleboro
LESKIEWICZ, HENRYK J., Cambridge
•MABB, WILLIAM S., Agawam

#### Michigan

FERENCE, MICHAEL, JR., Dearborn
LEVIN, BERNARD J., Detroit
MOODY, G. WILLIAM, Lansing
•TOJE, JOHN, Dearborn

#### Missouri

HARRIS, FRANKLIN D., Columbia
HOLMES, FOSTER W., St. Louis
NIERDIECK, MELVIN E., St. Louis
THURSTON, RAYMOND D., JR., Florissant
•WILDERMUTH, BLAIR L., Independence

#### New Jersey

GEUDER, ALAN B., Bergenfield
PEI, MING L., Bergenfield
•SCHMERZLER, LAWRENCE J., Livingston
ZEMO, FRANK J., Rahway

#### New Mexico

REAGAN, ROBERT L., Albuquerque

#### New York

DRAVES, ANDREW J., New York
GUDZ, GEORGE B., Bayside
GUZMAN-FRICKE, HANS A., New York
JAMES, THOMAS M., New York
JOHNSON, ROBERT J., New York
•LEVY, JACK B., Scotia
MATNER, VINCENT, Poughkeepsie
NORMAN, HOLLIS W., Buffalo
•SKALWOLD, ROBERT N., Rome
STRUBINGER, TAYLOR E., Bronx
UPTON, ERNEST F., JR., Poughkeepsie

#### North Carolina

DUNN, JACK M., Charlotte
MORTENSEN, RAYMOND K., Charlotte

#### Ohio

BURTON, BRUCE E., Ada
•DOLL, PHILLIP B., Lakewood

JOHNS, CLAIR M., Cleveland
MATT, RICHARD J., Cleveland
OLLENDORF, STANFORD, Cincinnati
PUNCH, WILLIAM F., Columbus
WHISLER, HOWARD E., Canton
WILKINSON, DWIGHT M., Cleveland

### Pennsylvania

ANTHONY, J. FIORELLI, JR., Pittsburgh
BORST, RAY, Pitcairn
●BRANDON, J. CAMPBELL, JR., Butler
CONLEY, JOHN E., JR., Erie
DE, LAKSHMAN C., Pittsburgh
●HOLLYDAY, JAMES H., New Holland
HOWARD, WILLIAM E., Media
●IMM, ARDEN L., Charleroi
PURDY, CHESTER M., Pittsburgh
●RAIMONDI, ALBERT A., Pittsburgh
SERAN, PAUL N., Clairton
VINSON, JACK R., Philadelphia
VISCOMI, B. VINCENT, Philadelphia
ZIMMERMAN, JOHN R., Allentown

### Puerto Rico

LEDESMA, RAFAEL, Bayamón

### Rhode Island

HALL, CHARLES G., Rumford

### South Carolina

DINOS, NICHOLAS, Aiken
WARNECKE, ARMAND E., Belvedere

### South Dakota

ULMER, JULIUS W., Brookings

### Tennessee

HAVILAND, WAYNE F., Signal Mountain
●RABUN, ROY E., JR., Chattanooga

### Texas

MASON, HARRY J., Baytown

### Vermont

●OUTWATER, JOHN O., Burlington

### Virginia

GEIGER, ARTHUR R., SR., Arlington
HATCHER, RAYMOND L., JR., Newport News
MARKS, COLIN H., Fort Belvoir
SCHLER, MORTON, Hampton

### Washington

MCELVAINE, HERBERT, JR., Everett
KISER, DANIEL P., Seattle
ROBEL, STEPHEN B., Seattle
TRUMPIS, ROBERT A., Seattle

### Wisconsin

ANTON, HERBERT D., Reeseville
GROTHUES, KARL G., Milwaukee
GRUENWALD, KENNETH H., Milwaukee
MATTERS, ROBERT G., Waukesha

### Foreign

BERNHARDT, ERIC, Baie D'Urfee P. Q., Canada
FLOWER, JOHN F. W., Downsview, Ont., Canada
FRIEDMAN, CHARLES L., Maracaibo, Venezuela
OCEGUERA, MANUEL, México, D. F., México
OSORIO, ALBERTO D. A., Rio de Janeiro, Brasil
●PÉREZ IZAGA, OSCAR J., Chiclayo, Perú
PRENTICE, WILBUR M., Toronto, Ont., Canada
SOMERS, GERHARDUS N., The Hague, The Netherlands
SPANJER, DAVID L., Montreal, Que., Canada
STOBAUGH, ROBERT B., JR., London, England
TARAFDER, JNANEN, Calcutta, West Bengal, India
VADAS, EPHRAIM F., Tel Aviv, Israel

## ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 per cent of the first year's salary if a nonmember, or 4 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

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## Men Available[1]

### New York Office

**Manager, Sales/Manufacturing, Mechanical,** thoroughly experienced light to heavy machinery sales and manufacturing from shops up through top-level responsibilities. Proved record of managerial, sales, and engineering accomplishments. Creative, self-starter, enthusiastic. Top administrative ability. Me-719.

**Liaison Engineer,** BSME; 23; two years' experience in sales, design, and production of nonferrous castings of high quality. Due to small size of company position offered diverse experience in all fields of business and engineering. Prefers East or West Coast. Me-720.

**Chief Engineer,** MS; 32; ten years' broad experience in steam-power and test-facility field, including complete administrative and technical responsibility of multimillion dollar projects. Prefers New York City or Northern N. J. Me-721.

**Plant Engineer,** BSME; 33; PE Delaware; ten years' experience in power and chemical-plant design, maintenance, and operations. Desires responsible position with progressive company requiring ability and initiative in this field. Prefers East Coast. Me-722.

**Instrumentation Engineer,** BSME; 32; five years project-instrumentation engineer investigating, designing, and developing equipment and techniques for measuring experimental project parameters. Desires position involving instrumentation preferably where equipment requires developmental application. PE N. Y. State. Prefers East, Midwest. Me-723.

**Director, Research or Development,** MS (ME); 45; 15 years varied research including its direction; five years teaching in mechanical-engineering department first-class university. Significant contributions to technical literature in several fields. Sales, management, experience. Location optional. Me-724.

**Project Engineer,** BSME, PE; 32; seven years' experience in rubber and plastics; OEM sales, product development, production engineering, machine design, purchasing, and cost reduction. Five years' toolmaking. Seeks responsible position in growing organization. Will relocate. Me-725.

**Engineering Administrator,** BS(ME), PE; 36; over five years branch manager and vice-president small consulting-engineering firm. Administrative and technical responsibility in area of evaluation testing, design analysis, and acceptance inspection of underwater ordnance. Location open. Me-726.

**Assistant to Engineering or Manufacturing Executive,** BME, MBA; 31; eight years' extensive experience in project and liaison engineering; design, development, manufacturing, test, and quality control. Project management, planning, estimating, scheduling, and proposals. Desires position with progressive organization. Location optional. Me-727.

**Technical Editor,** BSME; 30; presently associate editor on prestige technical monthly; seeks similar writing position with magazine, or on technical writing staff of manufacturer, or with public-relations firm. $9500. Prefers Northeast. Me-953-Chicago.

### San Francisco Office

**Manufacturing or Product Engineering, Water Heater or Tanks,** ME; 56; 13 years charge product engineering, manufacturing process, labor relations, and application engineering for manufacturing process, labor relations, and application engineering for manufacturer of gas-water heaters; 16 years plant manager, engineering, production as afore-mentioned plus aircraft-parts manufacture. $1000 a month and up. Prefers San Diego, Calif. Me-1945-SF.

**Draftsman, Designer, Mechanical Products;** 46; 20 years' experience drafting, detailing, and assisting in design of water turbines, piping, tools for manufacturers; gas motors, shipboard installations, ordnance, machinery for military production. $450 a month and up. Prefers San Francisco or elsewhere in Calif. Me-1914-SF.

**Chief Industrial Engineer, Manufacturing, IE;** 37; one year chief engineer, plant policy and administrative assistance on material handling, warehousing, methods for airframe manufacturer; two years' production engineering for food-processing company. $900 a month. Prefers western U. S. Me-1890-SF.

**Design, Development Engineer, Aviation Power,** ME; 37; three years' design, development turbomachinery, pneumatic control, and actuating systems for aircraft-power systems (engines, controls, and mountings). $10,000. Prefers western or eastern U. S. Me-1888-SF.

**Chief Production, Manufacturing, or Industrial Engineer, Paper Products;** 48; 24 years' experience as chief industrial engineer, prodution engineer, and manager and assistant superintendent on paper products, packaging, flexible wrapping, or packaging for manufacturer. $10,000. Will relocate. Me-1845-SF.

**Maintenance, Testing, or Field Engineer, Aircraft Components;** ME and Metallurgical Engineer; 30; six years test and acceptance of hydraulic and pneumatic components for aircraft manufacturer; four years maintenance aircraft structures, components, and systems. $650 a month. Prefers U. S. or foreign. Me-1598-SF.

**Plant Engineer or Designer, Mechanical;** for plant or contractor, ME; 47; one year commercial, mechanical design, installation supervision, heating and ventilating (mechanical) contractor; one year project engineer, heating, ventilating and piping on commercial, industrial, and public buildings, mechanical consultant; four years charge of heating, ventilating, air conditioning, industrial piping for engineer constructor; three years develop, design tooling, and production of new products, fan and ventilator manufacturer. $800 a month. Prefers San Francisco area. Me-1804-SF.

**Operations, Process Engineer, Refinery, Chemical;** MSChE (England); 26; two years' project planning and development, start up and supervision of operations in oil refinery; one year

[1] All men listed hold some form of ASME membership.

process improvement and operations investigations for chemical manufacturer. $575 a month up. Prefers San Francisco area. Me-1802-SF.

**Plant Engineer, Chemical, Allied Products;** ME; 59; 15 years' project, construction, design and plant engineer, major construction, expansion, and maintenance, cellophane, plastics, rayon, tire, fabrics manufacture; four years' molding plastic products; 12 years' plant maintenance and operation, chemicals. $10,000. Will consider any U. S. or foreign location. Me-1800-SF.

**Staff Engineer, Chemical, Petroleum,** ChE; 38; six years' principal engineer, design corrosion-control systems, supervise development and design standards, survey methods, specifications; perform surveys, write reports, make cost estimates and inspections, prepare and maintain manuals for a consultant; three years' supervision of process inspection, quality control, heat and chemical treatment on coatings and electroplating for aircraft manufacturer. $9000. Prefers West, South U. S., or foreign. Me-1768-SF.

**Managing Engineer, Steam, Nuclear;** ME; 37; 11 years manager design and construction, project engineer, designer and test engineer for manufacturer of steam-power apparatus and nuclear reactors; two years associate engineer, development of new manufacturing techniques, investigation of new applications for data-processing-equipment manufacturer. $12,000. Prefers Fla. or East of Mississippi. Me-1435-SF.

**Instructor, Consultant, Power Plant;** M E.; 30 years design, staff, engineering department, field on planning, operations, maintenance of steam-electrical generating plants for public utility; five years teaching hydraulics, kinematics, thermodynamics, power-plant engineering, and laboratory. Prefers San Francisco Bay area. Me-1741-SF.

**Sales or Technical Assistant, Chemical or Process Plants;** ME, MBA; 29; licensed in Calif. Three years client contact for engineering consultant; three years' sales and service of mechanical and electrical machinery or equipment. $6900 a year. Prefers San Francisco area or western U. S. Me-1737-SF.

**Staff Assistant, Industrial Engineer, Manufacturing;** engineering administration and business administration degree; 25; two years' high production industrial engineer, material handling, work allocation, methods, etc.; one year cost controls, analysis and reports, budgets, methods improvements for copper reduction. $650 a month. Prefers San Francisco area, general manufacturing. Me-1718-SF.

**Chief, Project, Consultant, Steam Generators, Boilers;** MS, ME: 41; four years chief engineer and consultant, manufacturer steam-cleaning and steam-generating equipment, application design, improvement re-design, shop production of fin tube and flash-boiler equipment, including supervision of draftsmen, etc.; one year project-engineering manufacturer of glass to metal color TV tubes. $12,000 a year. Prefers San Francisco East Bay. Me-1662-SF.

**General Manager, President, Industrial Products;** ME; 41; two years' division general manager industrial product business, (heating, ventilating, air conditioning); seven years manager engineering, project manager, manager marketing, manager contracts, manager sales and engineering for manufacturer of aircraft-accessory-power products, nuclear propulsion systems, aircraft-plant equipment. $25,000 a year. Prefers Calif. or western U. S. Me-1650-SF.

**Plant or Design Engineer, Chemicals, Rubber, Food;** MS; 30; seven years' varied experience covering plant engineering in chemicals, manufacture of photo equipment, training in use of atomic weapons, material-handling equipment, and molding of rubber products. Prefers San Francisco East Bay or northern Calif. Me-1624-SF.

**Application Engineer or Field Service, Gas Engines or Industrial Machinery,** ME; 31; five years field service of gas turbines for aircraft engines; three years sales and application engineering of industrial machinery. $575 a month up. Prefers San Francisco Bay area. Me-1587-SF.

**Consultant Assistant or Chief Engineer, Cranes or Material Handling;** ME; extensive high-level experience in design, application, production of overhead, gantry, traveling cranes, conveyers, electric mine hoists, ore cars, mechanical equipment for fission assemblies, and accessory gear for manufacturers of such equipment. Prefers San Francisco area. Me-1569-SF.

**Design, Production Engineer;** ME (England); 37; four years design, fabrication, construction pressure vessels; four years design, installation, construction refinery; four years supervision oil terminals. $10,000. Prefers San Francisco. Me-1547-SF.

# Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

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## ASME Master-File Information

Date

LAST NAME | FIRST NAME | MIDDLE NAME

POSITION TITLE | NATURE OF WORK DONE

e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) | Division, if any

*☐

EMPLOYER'S ADDRESS | City | Zone | State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

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HOME ADDRESS | City | Zone | State

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Professional Divisions in which I am interested (no more than *three*) are marked X.

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- ☐ L—Process Industries
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- ☐ N—Machine Design
- ☐ O—Lubrication
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- ☐ R—Railroad
- ☐ S—Power
- ☐ T—Textile
- ☐ U—Maintenance and Plant Engineering
- ☐ V—Gas Turbine Power
- ☐ W—Wood Industries
- ☐ Y—Rubber and Plastics
- ☐ Z—Instruments and Regulators

## Positions Available

**Superintendent** to manage shop for structural-steel fabricator and vessel builder. Must know metal fabricating, machining, and all kinds of welding processes. Engineering graduate preferred. Requires energetic person with leadership ability and cost consciousness. 150 shopmen. Salary open. East. W-7092.

**Packaging Engineer** to do planning of packaging-machinery installations, prepare specifications for machinery, follow-up preparation of construction drawings and specifications for contractors' use in bidding and installing the machinery and related conveyers, sheet-metal work and utility services. Must be qualified to carry a packaging project from beginning through to the production objective. About $10,000. Mich. W-7303.

**Teaching Position** available in mechanical engineering in the machine design and dynamics of machines area. Salary and rank dependent upon education and experience. East. W-7305.

**Factory-Planning Manager,** degree in mechanical or industrial engineering, at least ten years' experience in heavy industry. Will be responsible for directing department to provide effective plant layout, materials handling, and packaging services in heavy manufacturing plant. Will supervise preparation of all factory layouts; guide the design and necessary follow-up to insure economical packaging, crating, and skidding of a variety of products. To $13,000. Upstate N. Y. W-7312.

**Project Engineer,** graduate mechanical or electrical, at least two years' experience in project supervision of refinery or petroleum-chemical-plant design and construction, either with refinery engineering department or major contractor. Position with small, progressive engineering company primarily engaged in mechanical design of crude desalting and distillate treating plants. Some travel will be involved eventually. $7200–$8400. Southwest. W-7329.

**Production Supervisor,** to head up a new division on the production and assembly of fractional hp motors. $9000, plus or minus. N. Y. State. W-7331.

**Teaching Personnel.** (*a*) Head of mechanical-engineering department, PhD, teaching and industrial experience desirable. Rapidly growing new department in an expanding industrial area. Specialty in thermodynamics desirable but not necessary. $8000–$9500 for nine months. (*b*) Assistant or associate professor of mechanical engineering. Should be qualified in thermodynamics or machine design. Salary open, depending upon qualifications. West. W-7333.

**Consultant in Value Analysis,** graduate engineer, substantial experience in the U. S. in the application of industrial-engineering techniques to cost reduction of purchased parts and components, working with research and development engineers and vendors. Experience in automotive manufacturing would be most valuable. Fluent French advantageous. Apply by letter giving full details including salary requirements. France. F-7334.

**Centrifugal Pump Engineer** experienced in the design and development of centrifugal pumps, as well as the ability to develop estimates for specific pump applications, for company building special pumps for the major steel industries, coke plants, paper mills, etc. Salary open. East. W-7337.

**Plant Engineer,** mechanical-engineering background; extensive experience in operation and maintenance of large and varied building complex. Salary open. Position is with large New England institution. W-7338.

**Teaching Personnel, Department of Mechanical Engineering,** fall semester of 1959. Prefer PhD degree in engineering. Salary and rank dependent upon experience and degree. New England. W-7343.

**Mechanical Engineer,** graduate, experience in instrumentation design. Position will involve designing and installing custom instrumentation installations. Salary open. New England. W-7346.

**Production Engineer,** graduate mechanical preferred, graduate work most desirable. Work experience in steel or related industry, including blast-furnace operation and production. Executive ability. Excellent opportunity. $10,000–$12,000. Midwest. W-7358.

**Chief Specification Writer.** Must have had experience in the preparation of specification for government contracts, such as Corps of Engineers, Air Force, and Navy BuDocks. Should know mechanical and electrical specifications for industrial building, laboratories, defense projects, and support facilities. Salary open. Boston, Mass. area. W-7373.

**Engineers,** BSME, BSEE; graduate degree desirable. (*a*) Senior designer, five to ten years' experience in the design of precision mechanisms and power-control devices. Knowledge of aircraft hydraulic practices, materials, and very close tolerance manufacturing methods of prime importance. Must be capable of supervision of layout, detail drafting, and evaluation testing. (*b*) Design group supervisor to supervise a design-drafting department from establishment of technical standards to personnel administration. Must have good appreciation of precision-instrument design, considerations and manufacturing techniques. Knowledge of high-pressure hydraulics and aircraft components desirable. Five to ten years' experience required (*c*) Production engineering group supervisor, four to six years' experience in co-ordinating technical aspects of manufacturing of precision-control devices. Group workload includes negotation of customer specifications; definition of assembly and test criteria, procedures and equipment problems, and initiation of design changes. $9000–$14,000 to start, plus profit sharing. When submitting applications indicate current salary. Upstate N. Y. W-7374.

**Engineers,** BSME, BSEE; graduate degree desirable. (*a*) Environmental test and reliability engineer, three to five years' experience in environmental and qualification testing of airborne devices. Should have good appreciation of mechanism reliability considerations and techniques of testing to establish reliability. Must be capable of planning and supervising test programs, analyzing test results effectively, and working with designers to correct product deficiencies. (*b*) Development engineer experienced in the theoretical design, analysis, and experimental development of precision-control devices. Should combine ability to work with practical hardware and to apply feedback-control theory. Familiarity with electrohydraulic servomechanisms highly desirable. $9000–$14,000 to start, plus profit sharing. When submitting applications indicate present salary. Upstate N. Y. W-7375.

**Engineers.** (*a*) Technical editor to process reports, papers, and proposals in nuclear engineering department. Will establish standards and issue instruction material on format and style of technical documents. Two to three years' technical editing experience required. (*b*) Publications engineer to write operating, maintenance, and training manuals for water nuclear power plants. Familiarity with general instrumentation systems and the operation of a conventional-type power plant are desirable. Some experience with maintenance of pumps, heat exchangers, turbine generators, valving, etc. required. Two to five years' experience in preparing technical publications from blueprints and engineering data necessary. Submit résumés and salary requirements. Upstate N. Y. W-7381.

**Testing Supervisor,** MS or BS in mechanical or chemical engineering; physical chemistry or ceramics will be considered. Two to five years' experience in measurements required. Will participate in operation of a measurements laboratory for measurements at elevated temperatures of various thermal, mechanical, and electrical properties of new refractory materials. $7500–$10,000. New England. W-7383 (*a*).

**Personnel Director** for a midwest manufacturer of heavy machinery for company employing approximately 4000 people. Experience covers all phases of industrial relations in the metal-working or machinery business. $25,000–$30,000, plus benefits. W-7388.

**Engineers.** (*a*) Senior project engineer, graduate mechanical, experience in design, development of machinery to create new manufacturing techniques feasible for conversion to automation. Also, experience in electric motors, lighting components, material handling, etc., from creation of idea and equipment through design, installation, and production. $8268–$9000. (*b*) Cost-control manager, staff, graduate industrial engineer, experience in time study, standard cost, budgets, and cost control, to assist director of cost and production control to co-ordinate activities of cost-control sections to establish definite schedules; determine inventories of finished goods to be carried that will supply estimated requirements; determine economical lot-size production runs for parts, etc. $11,472–$12,144. Pa. W-7392.

**Engineers.** (*a*) Facilities engineer, degree in either civil, mechanical, or business engineering; master's degree in business administration desirable. Must have a broad background in business operations and finances. Will work in department whose function is to study, evaluate, make economic comparisons of various alternate approaches, determine final costs within close limits, and finally recommend to top management the course of action for the company's short and long-range manufacturing-expansion program. (*b*) Materials-handling engineer, mechanical or industrial engineering degree, at least seven years' actual experience on the materials-handling field. Experience in power and free conveyers, belt conveyers, feeding mechanisms, warehouse-handling equipment, and simple product-handling mechanisms. (*c*) Materials-handling engineer, graduate mechanical, at least three to five years' actual experience in the materials-handling field. Should have a knowledge of machine design to the point that he can visualize the design and cost of a machine in a material-handling system. Should have ability to transmit ideas to company's machine design group and follow its design. An appreciation for finished-product packaging equipment important. Salaries open. Company will pay moving expenses. Upstate N. Y. W-7393.

**Engineers.** (*a*) Mechanical engineer, to supervise drafting department. Should have broad knowledge of production techniques, materials, structural and heat-transfer techniques. Will work closely with engineering design group, production, and quality-control personnel. Should have had actual electrical-mechanical design experience. Should be familiar with layout drafting procedures. $7000–$10,000. (*b*) Development engineer, graduate mechanical or electrical, five years' experience on creative development work on components and/or small appliances. Should have some patents filed. To $10,000. Western Pa. W-7396.

**Junior District Sales Engineer,** college graduate, preferably technical degree, two to three years' industrial-sales experience. Should be accustomed to contacting purchasing agent, plant engineers, etc. Up to one year training prior to territorial assignment. Headquarters, western Pa. W-7397.

**Die Designer,** capable of advising product-design department on tooling and manufacturing problems during initial concept stages; capable of designing punch-press and press-brake dies with particular emphasis on press-brake forming. Dies will vary from simple to multistation compound progressive dies up to 300-ton capacity. Will be responsible for tool tryouts and die trouble shooting. Submit complete résumé including salary requirements. Boston, Mass., area. W-7398.

**Industrial Engineer,** time and motion study, production methods, planning, and cost experience covering fabrication of aluminum windows and building specialties. Knowledge of building construction practice desirable. $10,000–$12,000. New York, N. Y. W-7399.

**Design Engineer,** graduate mechanical, solid background in medium-heavy machine design; several years' experience in paper-converting field essential; some experience in development of new equipment. Field and customer contact experience. Will take full charge of the development of a completely new machine process having wide application in the paper-converting field. Permanent position. Salary open. Boston, Mass., area. W-7401.

**Works Manager,** engineering degree and at least ten years' supervisory industrial-engineering and production experience in primary metal mill covering sheet, strip, tubing, wire goods, etc. $20,000. Midwest. W-7405.

**Teaching Personnel.** (*a*) Department head for department of mechanics and electricity, PhD in ME preferred. (*b*) Teacher for department of mechanics and electricity, BS or MS in physics. Will teach mechanics, strength of materials, thermodynamics, applied electricity, general physics. Salaries and rank dependent on qualifications. (*c*) Teachers, for department of metallurgy. One to act as department head, PhD preferred, physical or process metallurgy. Teaching and research. Rank and salaries dependent on qualifications. West. W-7411.

**Manufacturing Engineer,** graduate, minimum of five years' experience as executive in mass production in the sheet-metal field. Must know thoroughly tools, jigs, and fixtures. $15,000–$18,000. East. W-7420.

**Designer,** mechanical, experience in fluid systems and components, particularly in so far as bellows designs for aircraft and missile work. Will work from customers' specifications. $9000, plus or minus. R. I. W-7421.

**Director of Management Development,** college graduate, for firm doing research and development and production in the missile and airframe industries. Will formulate and implement expanded program of executive, supervisory, and personnel development at the corporate level. Should know and be experienced in policy determination for corporate personnel-development programs. $20,000-a-year range, plus attractive benefits. Some travel between plants. Far West. W-7423.

**Senior Industrial Engineer,** degree in industrial engineering, or management with advanced course in industrial engineering, at least three to five years' industrial experience. Any experience in indirect labor incentive will be helpful; also with standard data. Duties will include establishing time standards, administrative incentive system, administrative job-evaluation plans, suggesting improvement in processing and packaging operations. Salary open. Central N. J. W-7426.

**Field Engineer, Sales,** graduate mechanical three to four years' experience in industrial selling of technical capital equipment. Must be able to make necessary technical computations to satisfy customer demands and insure proper application of equipment. Engineering calculations necessary to select the machine, driver, and accessories. Six months' training at main plant and six months' in field prior to account assignment. $6500–$8500. Territory; East, Midwest, or Southwest. W-7432.

**Production Engineer,** graduate electrical or mechanical engineer, minimum of two years' experience. Ability to design tooling and work on methods for small assembly operations essential.

Opportunity to develop new manufacturing methods and processes. To $9000. Employer will pay placement fee. Chicago, Ill., area. C-7389(*d*).

**Project Leader-Machine Development,** ME degree, ten years' experience in machine design and development, know design of processing equipment. Duties include being a project leader for junior engineers and draftsmen in the design and development of food-processing machinery and equipment. To $13,000. Employer will negotiate placement fee. Wis. C-7416(*a*).

**Chief Product-Design Engineer,** graduate, ME degree, five or more years' experience in the design and development of heavy machinery. Duties include heading up engineering department on design and development for a manufacturer of earth-moving equipment. Good Potential Salary $12,000 plus. Employer might negotiate placement fee. Ill. C-7418.

**Design Engineer, Heating, Ventilating, and Air Conditioning,** BSME, four years' experience in the field. Duties will include design and supervision of design for heating, ventilating, air conditioning, plumbing of office buildings, schools, churches, commercial and industrial buildings, etc. Should be registered in the State of Nebraska or be able to obtain license. Some traveling, no car required. Employer will negotiate placement fee. $7800–$9000. Omaha, Neb. C-7422.

**Engineer,** five or more years' of heating, ventilating, and air-conditioning design experience on process-type ventilation, air handling, and heating; pressure, temperature and humidity controls, hot-water and steam-heating systems, refrigeration. Employer will pay placement fee. Salary open. Chicago, Ill., area. C-7447 (*c*).

**Field Engineer,** graduate mechanical, ten years' experience in aluminum technology; should have extensive job-shop experience and progressed to foreman or higher; know aluminum fabrication, forming, bending, joining, finishing, etc. Will advise salesmen and customers regarding development of new aluminum products and general production problems of existing applications. Advise customers and other qualified technical personnel as to proper materials and processing pertinent to application and design of aluminum products. Develop new uses for aluminum and act as engineering consultant on new and existing aluminum application. Scope covers entire field of aluminum technology, 40 per cent travel; no car required. $8400–$10,200. Company will pay placement fee. Midwest and West. C-7459.

### *San Francisco Office*

**Staff and Operational—Public-Works-Type Activity:** Electrical, mechanical, civil, or related. Minimum of five to 20 years' with extensive recent supervisory experience required. To conduct engineering administration, operational and craftsman supervision for all base services and maintenance functions and operational support (other than new construction) on existing, complete, medium-size, self-contained installation equivalent to a large remote industrial, municipal, or military base including permanent housing, offices, shops, schools, hospitals—streets, water, electrical, sewage, sanitary, docks, warehouses, stores, airfield, and post. Resident engineer, to $20,000; assistant, to $17,000. General superintendent, to $18,000; assistant, to $14,000. Assisting (industrial relations, engineering design, safety, radiation) to $12,000. Superintendents (electrical, marine, building maintenance, distillation, communications, mechanical, utilities, power), to $16,000; assistants, to $14,000. Assisting engineers (design, draft), safety engineer, senior material take-off engineer, senior materials co-ordinator, to $11,000. Senior draftsman, material take-off, material co-ordinator, to $10,000. Assistant safety engineer, vehicle dispatcher, heavy equipment scheduler, draftsman, to $9,000. Family quarters, U. S. citizen only. Security clearance required. Two-year contract with renewal privilege. Top pay. Income-Tax exemption. Supporting positions for working wives. Pacific Ocean Area. Apply by letter of application with complete details of work experience. S-4355.

**Junior Engineer—Hardboard Products,** ChE or ME, graduate, prefer married man, some experience to work in research group on design and development of equipment for coating and finished hardboard. $400-$475 per month. Northern Calif. S-4352.

**Design—Heating, Ventilating, Air Conditioning, Plumbing:** ME, good practical working experience in design, layout, drafting, (able to draft and handle draftsmen) on plans and specifications of mechanical installation for general building. Must know code and practices. Able to handle contacts with architects, contractors, or clients for consultant; capable of handling complete job without supervision. To $700. Local applicants only San Francisco. S-4346.

**Sales—Instrumentation:** EE, ME, or ChE, three to five years' experience in instrumentation, engineering sales or industrial process plant, use of instruments. Prefer with some sales experience, will train three months in East Coast factory, must pass local aptitude test. Salary depends on experience and test rating; will sell full line of instruments (electrical, electronic, pneumatic, or hydraulic), recording, control actuators on temperature, pressure, flow, etc. For industrials and users. $500 up, depending on experience. San Francisco East Bay territory. Local man only. S-4341.

**Systems Engineers—Postal Machinery, Services:** Experienced in work measurements, methods, studies, services, to develop new improved systems, new concepts and design of equipment, mail handling, sizes on postal service, analyze information. (*a*) ME, EE, or Physics graduates, good statistician or mathematician, with five to ten years experience, strong on statistical work, analysis, evaluation, maintenance of information. (*b*) EE, ME, or Physics graduates, with five to ten years' experience, primarily in analytical work, applied mechanics, circuit experience, some computor experience desirable. $700-$1000 a month; for manufacturer. San Francisco Peninsula. S-4338-R.

**Designer—Industrial Machinery:** ME, machine-design option. At least two years' experience in creative industrial design; mechanical improvements; machine efficiency and plant-layout work. Start $570 plus, depending on experience. San Francisco East Bay. S-4334-R.

**Senior Design—Conveyers:** Graduate ME or equivalent, several years' experience preparing design drawings and specifications and handling small contracts. Must have good knowledge of mechanics of materials-handling machinery and equipment. To prepare detailed drawings and layouts of machinery, machine parts and steel work involving original design and calculations according to customers' requirements, specifications for shop fabrication, estimating, handle orders to fulfill contracts. To $625. San Francisco. S-4331.

**Management Trainee—Light Manufacturing:** ME, to enter into two-year training program including production, inventory control, and other phases of manufacturing of light sheet-steel products combining with plastics and synthetics. Must have top school grades and some business administration desirable. $500-$550 a month. San Francisco Peninsula. S-4322.

**Junior or Intermediate Designer—Production:** ME, qualified to provide assistance in development and test of small and medium-sized products made of sheet steel plus plastics or synthetics; to satisfy clients' needs. For manufacturer. $500-$550 a month, up. San Francisco Peninsula. S-4321.

**Project Engineer—Automation:** ME, minimum five or ten years designing and re-designing manufacturing machinery for conversion to automation control. Should be informed regarding shop production, automatic machinery, and assembly equipment on regular shop machinery (punch presses, coilers, etc.) for manufacturer of light metal and plastic products. $750–$800 a month. San Francisco Peninsula. S-4320.

**Designer—Analog Computors:** Degree, minimum five years' of actual and recent experience in designing and re-designing a line of analog computors or simulators. Should be informed about mechanical, mechanisms, transistorizing electronics, and electrical needs. Will participate in the general program at a project level; for manufacturer. $11,000, plus generous profit sharing. San Francisco East Bay. S-4318.

**Senior Engineer—Process Plant:** Graduate ME or ChE, design and operating experience preferably well versed on ASME-API codes. Will set up engineering office for new ammonia, sulfuric acid, and fertilizer plant, handle engineering of plant changes and advise operating and maintenance department on engineering problems. $800-$900 a month. San Joaquin Valley. S-4316.

**Plant Superintendent—Ammonia Plant:** ChE or ME, process engineering and operating experience, to take charge of a new ammonia and sulfuric acid plant. Responsible for operations and personnel. $10,000-$12,000. San Joaquin Valley. S-4315.

**Senior Industrial Engineer—Postal Services:** Graduate ME or EE, who has gone into industrial work. Should be experienced in human engineering, work measurements, methods studies; to develop new improved systems, new concepts, and design of equipment for postal service, work closely with postal employees, co-ordinate (not time study). $7,000-$1000 a month for manufacturer. San Francisco Peninsula. S-4294-R.

**Sales—Instruments:** EE preferred, or ChE, ME, two years' experience after graduation, to sell instruments (recording, actuating, direct reading) for temperature, pressure, flow to industrial, educational or laboratory users; also to handle digital computor contacts. For a manufacturer's distribution sales office. $122 a week up, plus car allowance and expenses. Car required. San Francisco. S-4294.

**Industrial Engineers—Office Systems; Time-Study, Methods:** IE graduate, experience in office-work measurement, systems, procedures, forms and control, to provide operational and management improvements and reports for an aircraft-operating company. To $650. ME graduate for time study and to assist in methods and procedures, production planning, equipment arrangement in maintenance shops for aircraft-operating company. To $500. San Francisco Peninsula. S-4288.

**Designer—Power Stations:** ME, at least 15 years of layout, planning, and design on heavy construction mechanical projects which must include five years of recent experience on hydro-electro stations and equipment. For consulting engineer. $650-$800. San Francisco. S-4283.

## OBITUARIES

**Donald Alvin Bridges (1910–1959),** design engineer, Electronics Component Div., Corning Glass Works, Bradford, Pa., died February, 1959. Born, Zanesville, Ohio, May 10, 1910. Education, attended Case School of Applied Science; BS(ME), Purdue University, 1936. Mr. Bridges was a registered professional engineer in the State of Kansas. He held patents for a glass wool cut-off device and miscellaneous glass block designs. Mem. ASME, 1958.

**Aubrey Ingerson Brown (1888–1959?),** whose death recently was reported to the Society, had been professor of mechanical engineering and chairman of the department, Ohio State University, Columbus, Ohio. Born, Wolfville, Nova Scotia, Canada, May 18, 1888. Parents, John Ingerson and Sophia Ermina (Zwicker) Brown. Education, attended Acadia University, 1906–1908, ME, Ohio State University, 1912. Naturalized U. S. citizen, Springfield, Mass., 1914. Married Sybil Charlotte David, 1914; one daughter, Barbara Grieg. Registered engineer in the State of Ohio. A specialist in the field of heating, air conditioning, and ventilating, Professor Brown had published a number of articles on the subject. He was the author of a textbook, "Introduction to Heat Transfer," published by McGraw-Hill. He was a member also of ASHVE, SPEE, Sigma Xi, and Tau Beta Pi. Mem. ASME, 1914; Mem. ASME, 1921. He served the Society as a member of a Technical Committee on Theory and Fundamental Research of the Heat Transfer Division.

**Donal Edward Brown (1921–1958),** design engineer, Miles P. Brown Boiler Works, Franklin, Pa., died Oct. 10, 1958. Born, Oil City, Pa., April 21, 1921. Education, studied mechanical engineering at Grove City College, 1939–1940. Assoc. Mem. ASME, 1945. He had been with Miles Brown Boiler Works since 1941.

**Clifford Scholes Cody (1901–1958),** senior representative Rolls-Liaison Work, Aviation Gas Turbine Div., foreign relations depts., Westinghouse Electric Corp., Kansas City, Mo., died June, 1958. Born, Sioux City, Iowa, Sept. 12, 1901. Parents, William E. and Eugenia A. Cody. Education, BS(ME), Iowa State College, 1924. Married Gladys A. Johnson, 1926; children, Marlyn A.; Joan L.; and William C. Cody. Mem. ASME, 1956. Mr. Cody held more than ten patents. He had been with Westinghouse since 1936.

**Thomas Francis Darcy (1897–1959),** mechanical superintendent, Frederick Snare Corp., New York, N. Y., died Feb. 24, 1959. Born, Brooklyn, N. Y., Jan. 28, 1897. Education, high-school graduate, Mem. ASME, 1952. A licensed engineer in the State of New York, Mr. Darcy had been with the Snare Corp. since 1914. Survived by his widow, Mary Darcy.

**Kern Dodge (1880–1958),** consulting engineer, Philadelphia, Pa., died Nov. 6, 1958. Born, Chicago, Ill., July 20, 1880. Parents, James Mapes and Josephine (Kern) Dodge. Education, Drexel Institute, 1901. Married Helen Peterson Greene, 1904; four children, Dorothy Dodge Whelihan (dec.), Donald Dodge, Jane Dodge Barnett (dec.), and Robert Mapes Dodge. Married 2nd, Helen McCracken Fessenden, 1952. Assoc. Mem. ASME, 1902; Mem. ASME, 1912. Mr. Dodge formed a partnership with Charles Day under the firm name of Dodge & Day, consulting engineers. In 1912 he sold his interest in the firm which continued under the name of Day & Zimmerman. From that time he had been in private consulting practice. He was a registered professional engineer in the

State of Pennsylvania. He was a member also of AIEE and the Franklin Institute.

**Walter Joseph Foley (1881–1958?),** retired dredging engineer, Standard Dredging Corp., Boise, Idaho, died recently according to a report received by the Society. Born, San Francisco, Calif., May 10, 1881. Education, California School of Mechanical Arts. Assoc. Mem. ASME, 1910; Mem. ASME, 1923.

**James Harry Garrett, Jr., (1933–1959),** Lieutenant, U. S. Air Force, Great Falls, Mont., died Feb. 6, 1959, in a jet plane crash. Born, Camden, Ark., Feb. 11, 1933. Education, BS(ME), Louisiana Polytechnic Institute, 1955. Assoc. Mem. ASME, 1955. Lieut. Garrett is survived by his widow and one child.

**Loren Loomis Hebberd (1887–1959),** chief engineer, Ramtite Co., Chicago, Ill., died Feb. 19, 1959. Born, Galesburg, Ill., July 25, 1887. Parents, Edward A. and Rozetta (Loomis) Hebberd. Education, ME, University of Wisconsin, 1911. Married Dorothy Berry, 1916. Assoc. Mem. ASME, 1912; Mem. ASME, 1915. Mr. Hebberd was a registered professional engineer in Illinois and Wisconsin. He was a member also of TAPPI. Survived by his widow.

**Samuel Parker Hunt (1872–1958?),** whose death recently was reported to the Society had been a consulting engineer, Manchester, N. H. Born, Manchester, N. H., Feb. 3, 1872. Parents, Nathan Parker and Elizabeth Sophia (Bisbee) Hunt. Education, AB, Dartmouth College, 1893; AM, 1896; BS (EE and CE,) Massachusetts Institute of Technology, 1895; also attended Harvard Graduate School of Business Administration and Middlebury Summer School of Languages. Married Lucy Agnes Rowell, 1907. Mem. ASME, 1925. Mr. Hunt was a registered professional engineer in New York and Pennsylvania. He was a specialist in the field of light and power. He was the author of papers published in professional journals and of a paper (with G. S. Foster) on the serological diagnosis of cancer. Member also of AAS, ACS, and AIEE.

**Joseph Kissick, Jr. (1923–1959),** partner in Kissick Co., New York, N. Y., died March 12, 1959. Born, New York, N. Y., July 16, 1923. Education, BME, Cornell University, 1945. Assoc. Mem. ASME, 1948; Mem. ASME, 1957. Before joining his father's concern, Mr. Kissick had been chief engineer of the Copes-Vulcan Co., a division of Blaw-Knox Co. Survived by his widow, Claudia; his parents, Mr. and Mrs. Joseph Kissick, Armonk, N. Y.; and a sister, Mrs. John Rossland.

**Gerhardt Elmer Klapper (1915–1959),** senior engineer, Philadelphia Electric Co., Philadelphia, Pa., died in a helicopter crash on Feb. 27, 1959. Born, Bryn Mawr, Pa., June 1, 1915. Education, BS(ME), University of Pennsylvania, 1937. Mem. ASME, 1954. Mr. Klapper had been with Philadelphia Electric Co. since 1946. He was responsible for the design and co-ordination of all mechanical items for the firm's $50-million Cromby Generating Station. During World War II, he served as lieutenant commander in charge of ship repair and overhaul work on more than 2000 ships of all types. He had published work in the *Transactions of the AIEE*. Mr. Klapper was a registered professional engineer in the State of Pennsylvania. He was a member also of ASHVE and NSPE.

**Fred Victor Koenig (1915–1959),** chief engineer, Engineers Limited, Mechanical Construction Co., Los Angeles, Calif., died Feb. 4, 1959. Born, New York, N. Y., May 29, 1915. Parents, Fred and Margaret Koenig. Education, BSE, Cooper Union, 1940. Married Lillian F. Rohe, 1941; two daughters, Lindella Diane and Karen Frances. Assoc. Mem. ASME, 1941. Mr. Koenig was a registered professional engineer in the State of California. Survived by his widow and two children.

**Howard F. Lawrence (1883–1959?),** retired, Middletown, Ohio, died recently according to a notice received by the Society. Born, Middletown, Ohio, Sept. 10, 1883. Education, ME, Stevens Institute of Technology, 1907. Married Grace C. Roney, 1908. Assoc. Mem. ASME, 1908; Mem. ASME, 1922. Mr. Lawrence was a specialist in the field of coal combustion, particularly mechanical stokers. He had been associated with the American Engineering Co., Philadelphia, Pa. Survived by his widow, Grace Roney Lawrence; one brother, Walter F. Lawrence; and a sister, Mrs. Jennie Michael.

**James Edward Leddy (1898–1957),** whose death in November, 1957, has recently been brought to the attention of the Society, was chief inspector, department of public safety, City of New Orleans, La., Aug. 24, 1898. Education, Spencer College, 1915. Mr. Leddy had been employed by the City of New Orleans since 1935. Mr. Leddy had also been chief engineer on various merchant marine vessels. He held a chief engineer unlimited license issued by the U. S. Bureau of Marine Inspection. He was a registered engineer in the State of Louisiana. Affiliate ASME, 1946; Mem. ASME, 1951.

**John Herman Levinson (1879–1959),** consulting engineer, Philadelphia, Pa., died Jan. 21, 1959. Born, Chicago, Ill., Sept. 29, 1879. Parents, Sigismund and Badona Levinson. BS(ME), Armour Institute of Technology, 1904. Married Dora Berman, 1905; two daughters, Dr. Badona Levinson and Mrs. Sandra L. Bashaw. Mem. ASME, 1929. Mr. Levinson was a registered professional engineer in the States of Pennsylvania and New Jersey. He was a specialist in the field of power-plant design and operation, refrigeration, heating, ventilating, and air conditioning. He was a member also of the Society of American Military Engineers.

**Scott Ward McBurney (1935–1959),** formerly design engineer, Ellerbe & Co., Minneapolis, Minn., died Feb. 20, 1959. Born, Minneapolis, Minn., Jan. 18, 1935. Education, BS(ME), University of Minnesota, 1957. Assoc. Mem. ASME, 1957. Mr. McBurney was in Europe with the armed services at the time of his death.

**Edgar Hammer Miller (1922–1959),** eastern editor, *Electric Light and Power Magazine*, Haywood Publishing Co., New York, N. Y., died Jan. 20, 1959. Born, Jan. 7, 1922. Education, BS(Bus. Admin.), Lehigh University, 1948; BS(IE), 1949; attended Stevens Institute of Technology. Assoc. Mem. ASME, 1956. Mr. Miller joined Haywood Publishing Co. in 1956. Prior to that time he had been with Public Service Electric and Gas Co. Survived by his widow, Margaret R. Miller, Mt. Tabor, N. J.

**Harold Kenneth Miller (1904–1959),** project engineer, Wyandotte Chemical Corp., Wyandotte, Mich., died Jan. 22, 1959. Born, Fort Wayne, Ind., July 31, 1904. Parents, Eli and Lona Miller. Education, BS(ME), Tri-State College, 1926. Married Gertrude J. Jepson, 1931. Mem. ASME, 1949. Mr. Miller held a patent, assigned to Wyandotte, for a power driven portable valve operator. Survived by his widow and a son, H. Kenneth Miller, Jr., both of Grosse Ile, Mich.

**Roy Otley Neal (1894–1959),** manager and owner, Harley Sales Co., Tulsa, Okla., died Feb. 8, 1959. Born, Findlay, Ohio, Aug. 10, 1894. Education, BS(CE), University of Kansas, 1916; CE, 1919. Mem. ASME, 1947. Mr. Neal had been associated with the Harley firm since 1928. A registered professional engineer in the State of Oklahoma, he was the author of a number of papers on the subject of petroleum technology published by the U. S. Bureau of Mines.

**Richard Francis O'Brien (1905–1958),** manufacturers' representative and consulting engineer, Philadelphia, Pa., died Feb. 16, 1958. Born, Schenectady, N. Y., Nov. 19, 1905. Parents, Richard and Edna (Irving) O'Brien. Education, General Electric Trade School, 1927; ME, Rensselaer Polytechnic Institute, 1931. Married Julia K. O'Brien, 1934; two daughters, Rosemary and Margaret. Mem. ASME, 1955. During World War II, Mr. O'Brien was one of five men chosen to start a fuel oil training school. Several papers written by him were used as text material at the Naval Fuel Oil Burner School. He was a registered professional engineer in the State of Pennsylvania. Member also Sigma Xi. Survived by his widow and two daughters.

**Snowden Bayard Redfield (1880–1958),** retired, engineer in charge of rotary compressor design, Fuller Co., Catasauqua, Pa., died Sept. 22, 1958. Born, Paris, France, April 25, 1880. Parents, John B. and Martha A. Redfield. Education, BS(ME), University of Pennsylvania, 1902; ME, 1929. Married Mildred H. Adey; one daughter, Barbara. Mem. ASME, 1910. Mr. Redfield held numerous patents for pneumatic devices assigned to Ingersoll-Rand and Fuller Co., firms with which he had been associated. For a time he had been an associate editor of *American Machinist*. He had contributed many articles to *Power* and *Heating, Piping, and Air Conditioning*. Member also of Sigma Xi. Survived by his widow.

**Albert Thomas Rowan (1902–1959?),** design engineer, National Gypsum Co., New Orleans, La., died recently according to a report received by the Society. Born, New Orleans, La., July 21, 1902. Education, high-school graduate and Louisiana State University and Columbia University Extension Schools. Mem. ASME, 1948.

**John Burtis Saxe (1902–1959),** vice-president and chief consulting engineer, Gibbs & Hill, Inc., died Feb. 15, 1959. Born, Brookline, Mass., July 27, 1902. Parents, John W. and Sarah (Burtis) Saxe. Education, BS(CE), Harvard Engineering School, 1923. Married Lorraine Brooke, 1928; two sons, John B. and Walter B., Jr. Mem. ASME, 1943. Mr. Saxe had been with Gibbs & Hill since 1924. He directed many of the firms's diverse projects among them power-plant projects, including nuclear power plants, in Belgium, Spain, Italy, Taiwan, Venezuela, and Columbia. He was a registered professional engineer in the State of New York. He held a patent for an electric indicating system. Survived by his widow and two children.

**Robert Marzelos Schiewe (1933–1959),** research engineer, Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif., died March 8, 1959. Born, Indianapolis, Ind., Dec. 25, 1933. Parents, Arthur H. and Gladys (Lightle) Schiewe. Education, BS(ME), Purdue University, 1956; MS, 1958. Assoc. Mem. ASME, 1956. Mr. Schiewe was a member also of Tau Beta Pi.

**Charles Ignatz Sibler (1896–1959),** chief engineer, West Virginia Pulp and Paper Co., New York, N. Y., died March 12, 1959. Born, Zurich, Switzerland, April 16, 1896. Education, ME, Swiss Federal Technical University, 1920. Naturalized U. S. citizen. Mem. ASME, 1944. Mr. Sibler, an authority on steam and power, had been with the paper company for 22 years. He directed the firm's $200-million postwar expansion program, introducing many advanced engineering techniques. He was the author of a number of articles for technical books and magazines. He served the Society as chairman of the Air Pollution and Boiler Code Committees. He was a member also of TAPPI, NSPE, and the Newcomen Society. Survived by a son, Carl Frederic, and three brothers and three sisters in Switzerland.

**Ben D. Smith (1906–1959?),** whose death recently was reported to the Society had been general supervisor, mechanical engineering research section, International Harvester Co. Born, Eaton, Ind., Dec. 31, 1906. Education, high-school graduate and ICS. Mem. ASME, 1946. Mr. Smith had been with International Harvester since 1926.

**George Cornwell Taylor (1895–1958),** engineering staff supervisor, Westinghouse Electric Corp., Philadelphia, Pa., died Dec. 29, 1958. Born, Pasaic, N. J., Dec. 18, 1895. Parents, Franklin E. and Mary Agnes Taylor. Education, attended Gettysburg College. Married Emma Irene Kreidler, 1923; daughter, Joan Irene. Mem. ASME, 1928. Mr. Taylor had been at Westinghouse since 1918. A specialist in the fields of steam turbines, condensers, heat exchangers, and steam jet refrigeration, he held a number of patents. He served during World War I in the U. S. Army Air Service and Field Artillery.

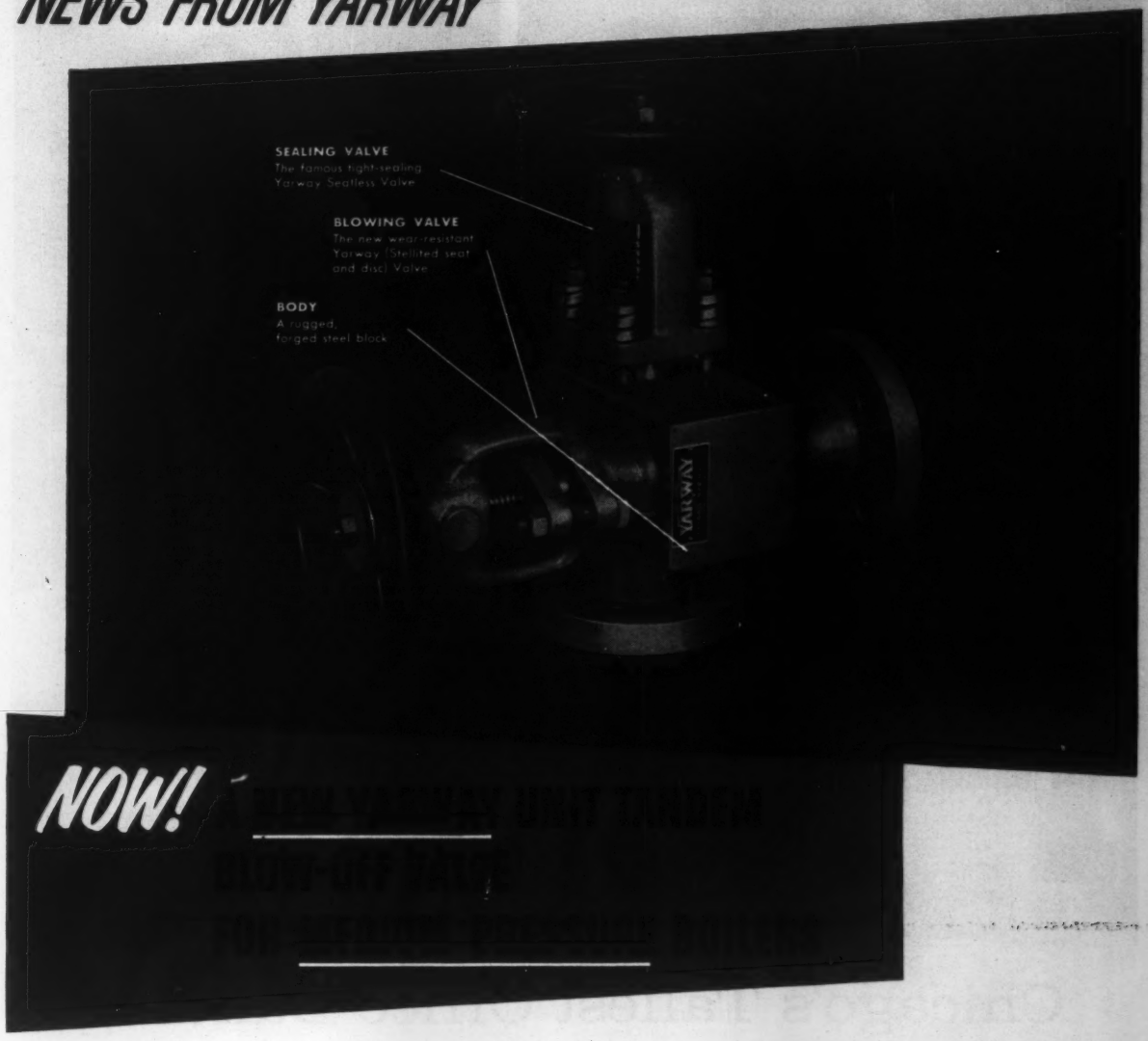
**Robert Edwin Turner (1901–1959),** plant engineer, The Susquehanna Electric Co., an affiliate of Philadelphia Electric Co., Conowingo, Md., died Feb. 27, 1959. Born, Odebolt, Iowa, March 23, 1901. Parents, George H. and Martha (Henderson) Turner. Education, BS(EE), Iowa State College, 1921; CE, 1946; attended University of Pennsylvania and The Johns Hopkins University. Married Rebecca A. Blish, 1928; children, Ruth E., Martha J., Roberta N., Barbara A., and Edwin Odell Turner. Mem. ASME, 1939. Mr. Turner had been with Philadelphia Electric and its subsidiaries since 1926. He contributed several articles to technical journals and was the author of numerous technical reports. He was a registered professional engineer in the State of Maryland. Member also of AIEE, ASCE, AAAS.

**Arthur Robert Weismantle (1912–1959),** manager of contracting planning, Equipment Div., Foster Wheeler Corp., New York, N. Y., died March 9, 1959. Born, New York, N. Y., Sept. 18, 1912. Education, AB, Columbia University, 1934; BS(ME), 1935; MS, 1936. Assoc. Mem. ASME, 1936; Mem. ASME, 1952. Mr. Weismantle joined Foster Wheeler in 1936. He had served the Society as a member of the Executive Committee of the Metropolitan Section. He was the author of a number of papers published here and abroad. He was a registered engineer in the State of New York. Member also of ASTM and the Air Pollution Control Association.

**James Clements Wheat (1888–1959?)** whose death recently was reported to the Society had been assistant to the president, Industrial Brownhoist Corp., Bay City, Mich. Born, Leavenworth, Kan., Nov. 7, 1888. Education, BS(EE), University of Michigan, 1909; MS (ME), 1910. Mem. ASME, 1944. Mr. Wheat had been with Industrial Brownhoist Corp. since 1912.

**Ernest Neall Wright (1861–1959),** retired, Pasadena, Calif., died March 5, 1959. Born, Philadelphia, Pa., March 27, 1861. Parents, James A. and Mary C. Wright. Education, ME, Stevens Institute of Technology, 1883; attended Technische Hoshschule, Hanover, Germany, and University of Goettingen. Married Kathleen Robinson, 1889. Mem. ASME, 1890. Mr. Wright retired in 1905. He had been associated with Westinghouse, Church, Kerr & Co. and American Superheater Co. After his retirement Mr. Wright devoted much of his time to golf. He had, in 1903, defeated the seemingly unbeatable, W. J. Travis, National Amateur Golf Champion. He was an influence in improving golf courses in the West, and was a force in changing California courses from hard dirt to turf. Survived by his widow, a daughter, and three sons.

# NEWS FROM YARWAY




## NOW!

There's a new star in the Yarway Blow-Off Valve line.

For years rugged Yarway Unit Tandem Blow-Off Valves have been standard equipment on most high pressure boilers. In fact, more than 80% of high pressure plants use Yarways.

Now a *new design* Unit Tandem is offered for *medium pressure boilers to 665 WSP.* Streamlined, lighter in weight, easy to operate, tight sealing and long wearing—this valve brings premium quality Yarway Unit Tandem dependability to the medium pressure field—*at a competitive price!*

Important features, like the nitralloy plunger in the sealing valve and integral stellite seat and disc in the blowing valve, make this your best buy for blow-off service.

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For full details write for Yarway Bulletin B-435, Supplement A.

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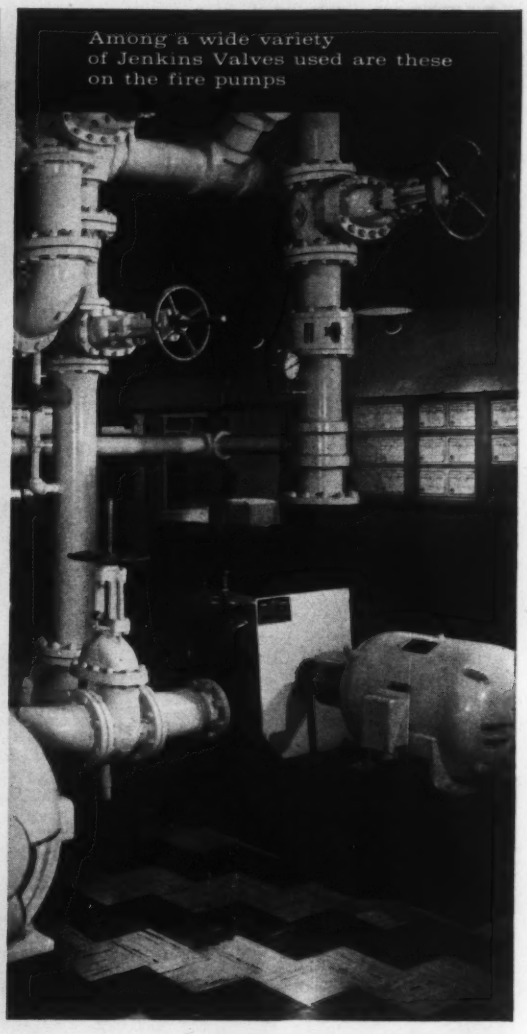


# Chicago's Tallest Office Building

## Mid-America Home Office of **The Prudential Insurance Company of America** relies on JENKINS VALVES

Well-known for careful selection of investments and concern about controllable operating expenses, The Prudential Insurance Company of America sought the soundest of values when building its new 40 million dollar Mid-America Home Office building.

This applied to the valve equipment, and the contractor installed *Jenkins Valves* to control the plumbing and sprinkler systems. Made for a Lifetime of service, and to a known quality standard which has been unvarying for nearly a century, Jenkins Valves provide the fullest protection against costly valve maintenance and replacement.

It is protection that can save money for any plant or building. And, you can specify or install Jenkins Valves knowing they cost no more. Jenkins Bros., 100 Park Avenue, New York 17.

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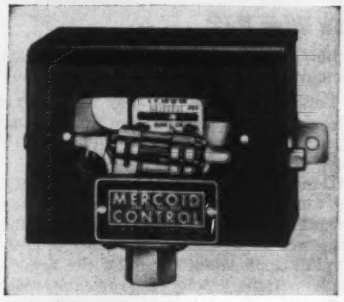



## Pressure Controls

Mercoid Corp. announces a newly designed pressure control designated as Type AP-153, recommended for applications involving air, or gases, not injurious to steel or silver solder.

According to the company, its small size and light weight, $1^{3}/_{4}$ lb make it particularly suitable for mounting where limited space is available or for mounting on wiring channels.

Features include external adjustment, repetitive trip point, visible calibrated dial with pointer, visible hermetically sealed mercury contact. Operating range (adjustable) is 1 to 20 psig, and differential (fixed), 0.5 psig. Maximum pressure is 30 psig. Operating point is set by external adjustment. —K–1

## Centrifugal Clutches

A new line of packaged clutches, including pulleys, designed for heavy no-slip service and minimum maintenance on midget autos, scooters, golf carts, riding mowers, and similar applications is announced by Fairbanks, Morse and Co., Magneto Div.

Six models, three with 3-in. diam clutch and three with $3^{1}/_{2}$-in. diam clutch are included in the line. The firm explains that since they are centrifugal clutches the engine or motor starts without a load and builds up to proper speed before clutch engages.

Shaft sizes accommodated by the smaller diameter clutch are $^{1}/_{2}$, $^{5}/_{8}$, and $^{3}/_{4}$-in. while the larger clutch is designed for shaft diameters of $^{5}/_{8}$, $^{3}/_{4}$, and 1-in. Pulley diameter in 3 in. except for the model designed for the 1-in. shaft which takes a $3^{1}/_{2}$-in. pulley. —K–2

## Assembly Tools

Two new retaining ring assembly tools which combine applicators and magazine-fed ring dispensers in one unit have been developed by Waldes Kohinoor, Inc.

Known as the Truarc Ring-Gun and Ring-Jector, the tools are designed for use in the automotive, business machines, electronics, electrical appliance and equipment industries and other fields where high-speed, assembly-line ring installation is required. The tools are said to be particularly suitable also for ring applications in which the work piece is too large to be brought to a fixed assembly station.

They may be used with the firm's Series 5103 crescent rings, Series 5133 E-rings and Series 5144 reinforced E-rings for shafts ranging in diameter from .125 to .375 in.

The Ring-Gun is shaped somewhat like an oversized Luger pistol. It is loaded with rings simply by removing a feeder guide and slipping a Rol-Pak of stacked rings over the back of the magazine rail. When the tape is removed and the feeder guide replaced, a spiral spring attached to the feeder pushes the rings forward to a recess in the applicator blade at the front of the tool.

The trigger is connected to an actuating lever located opposite the applicator blade. The lever has a tongue which corresponds in thickness to the width of the groove in which a ring is to be assembled.

The Ring-Jector resembles a hand stapler in appearance. It is loaded with rings in much the same manner as the Ring-Gun: a feeder guide is removed and a pack of stacked rings slipped over the magazine rail. Instead of a spiral spring, however, the tool has a coil spring which feeds the rings forward to the applicator blade.

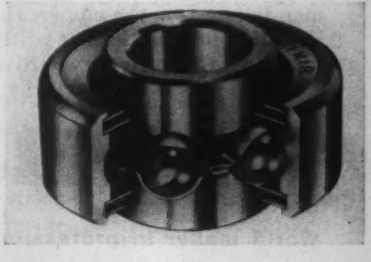
To install a ring, the trigger is squeezed so that the first ring in the stack protrudes partially from the applicator blade. The ring is then inserted into the groove and the entire tool pushed forward to lock the ring on the shaft. —K–3

## New Technical Paper

The Clearprint Paper Co. announced the availability of its new Pre-Print technical paper providing a pre-print of recurring typical details, basic standards, title block information, bills of materials, legends, symbols, etc. In addition, optional items of frequent recurrence are printed in the Fade-out process on Pre-Print paper. When desired to appear in the final printing, pre-printed details are simply penciled or inked over.

Pre-Print is printed on Clearprint No. 1000H or 1020 paper with Fadeout lines on the reverse side permitting repeated erasures without destroying the guide lines. It gives draftsmen and engineers a head start and saves drafting and lettering time. Fadeout lines completely disappear when drawings are made into blue prints. Additional informational and catalog material available.

"Pre-Print," "Fade-Out" and "Clearprint" are registered trade marks of the Clearprint Paper Co. —K–4



## Aircraft Bearings

A new series of high temperature, low-torque, sealed ball bearings for high speed aircraft has been announced by Fafnir Bearing Co.

Designated the AW-AK series, the new bearings were designed specifically for sensitive aircraft control applications. The firm reports the bearings are fabricated entirely of stainless steel, are heat-stabilized, and lubricated with heat resistant oil.

The new medium capacity series is available with Teflon fabric seals capable of withstanding temperatures in the 550 range. These seals hold seal drag to a minimum, the firm states.

The series is equipped with stainless steel ball separators that insure extremely low torque. Bearing widths to close tolerances are designed to permit easy mounting in standard brackets. —K–5

**For instant-action board movement . . . closer, faster reference checking—try the all-new Hamilton L-Contour table**

Hamilton L-Contour drafting tables give instant board movement from horizontal to 90 degrees . . . adjust a full 20 inches vertically to bring any size drawing into comfortable working position. The large, convenient reference unit—optional at either right or left of board—keeps catalogs, blueprints, specifications in full view at all times. Work gets done faster—with fewer mistakes and less draftsman fatigue—on the all-new Hamilton L-Contour table. See it at your Hamilton dealer's or write for full details—Hamilton Manufacturing Company, Two Rivers, Wisconsin.

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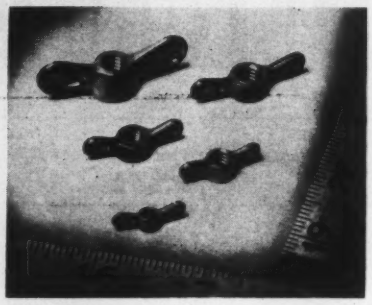

### Low Wing Nuts

Low wing nuts are now die cast in a complete line by Gries Reproducer Corp.

The firm says the zinc alloy fasteners can be supplied in thread sizes from No. 5 through $^{3}/_{8}$ in. and in wing spreads of $^{13}/_{16}$ through $1^{7}/_{8}$ in.

Designed with a streamlined low silhouette, the nuts are used where low wing height is needed or where the projection of a standard wing nut might introduce a snag problem. Typical applications listed by the firm include portable tools; instruments; paint rollers; brush, mop, and waxer refills; play pens; crutches; packing cases; tripods; air and oil filters; display cases. **—K-6**

### Submersible Motor

Louis Allis Co. recently announced production of a 4-in. submersible motor, designed to drive deep well turbine pumps in domestic and industrial water supply applications.

The firm states that the motor provides the highest horsepower capacity now available in a motor of that diameter. Ratings offered in single phase construction are from $1^{1}/_{2}$ to 5 hp. In three phase construction, ratings extend from $1^{1}/_{2}$ to $7^{1}/_{2}$ hp at 3550 rpm.

According to the company, greater horsepower capacity for its size is achieved by using an outside wound stator. This construction permits more effective use of copper and iron for higher efficiency and torques. The motor stator is protected by a high dielectric insulation system, by encapsulation in a chemically inert plastisol and by sealing in stainless steel.

Shaft height on the motor can be adjusted to center pump inpellers for optimum pump efficiency. An exclusive design feature on the adjusting mechanism prevents overadjustment that could damage the motor. Another special design feature incorporates a self-equalizing thrust bearing with a carbon thrust pad and six self-aligning hardened, stainless steel tilting shoes, mounted on a spherical seat.

Bearing brackets are of cast iron. The thrust bearing is stainless steel and all other exposed parts are either stainless steel, brass, or neoprene. **—K-7**

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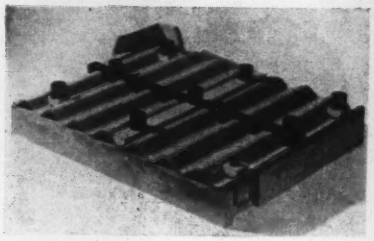

### Non-Corrosive Underdrain

Corru-Drain, a patented, noncorrosive underdrain design for rapid sand filters, has been introduced by Graver Water Conditioning Co. It is described as being unique in that it is made of corrugated asbestos-cement sheets with the corrugations forming the laterals.

The firm says the drain has many advantages because of its light weight, toughness, ease of shipping and handling, and simplicity of installation. Its design also provides for optimum backwashing distribution because of the method of orifice arrangement. It can be installed in new filters and is adaptable for replacing underdrains in existing filters with a minimum of structural changes.

A major advantage claimed for the new design is the saving of labor due to the simplicity of installation. In an actual field comparison it took only 72 man-hours to install a 342 sq ft unit having a 1,000,000 gal capacity. Installation time for a competitive underdrain in an identical filter came to 168 man-hours.

Corru-Drain does not require leveling, reinforcing rods, presetting of anchor bolts, extensive form work or concrete piers for support, or access man-holes. Installation can be started immediately after the filter forms have been removed. —K-8

### Stainless Steel Tubing

Small, cold-drawn tubing of PH 15-7 Mo, a new precipitation-hardening stainless steel analysis said to have excellent mechanical properties at room temperatures and outstanding ones at elevated temperatures, is now supplied by Superior Tube Co.

A patented analysis of Armco Steel Corp., PH 15-7 Mo contains 14 to 16 per cent chromium, 6.50 to 7.75 per cent nickel, 2 to 3 per cent molybdenum and 0.75 to 1.50 per cent aluminum. The molybdenum increases the mechanical properties of the alloy at temperatures up to 1000 F.

The alloy is hardenable with minimum distortion by low-temperature heat treatments. In addition, the firm states, it work hardens rapidly. In the heat-treated condition it is extremely hard and strong. Its spring properties are similar to those of AISI Type 301 stainless steel. —K-9


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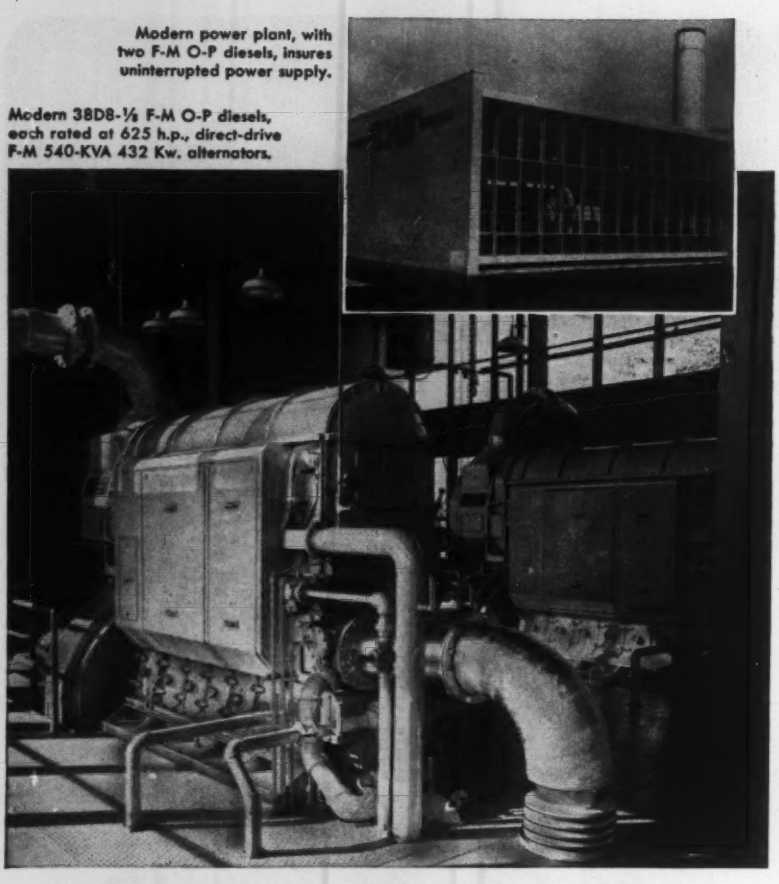

# Miner installs power security!

In line with an increasing trend among institutions and industries, the new William H. Miner Agricultural Research Institute near Chazy, New York has installed a complete Fairbanks-Morse diesel-electric plant as positive protection against power failure.

The compact installation shown above features two Fairbanks-Morse Opposed-Piston diesels, direct-driving Fairbanks-Morse alternators.

The plant is completely self-sufficient. Should the area's hydro power supply fail, a 6-kw. Model 45 F-M diesel-generator set powers a motor-driven starting air compressor and pre-lube pumps to let the operator start one of the big F-M diesels in a hurry.

Find out why F-M two-cycle Opposed-Piston diesel power is unsurpassed for compactness, dependability and economy. Write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

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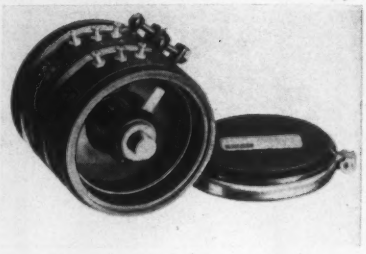

### Precision Potentiometer

G. M. Giannini & Co. announces its Model 1750 single-turn precision potentiometer, 1¾ in. in diam and is built to NAS-710 standard, Style RR-18.

The firm says the unit is highly accurate with linearity to ±0.1 per cent, resolution of 0.030 per cent, and total resistances ranging from 10 to 300,000 ohms. The mounting surface is anodized aluminum with cups and rear cover of shock and humidity resistant molded plastic.

It can be supplied singly, or in externally phaseable ganged units. Unitized construction is designed to simplify unusually long ganging. Switch elements can be incorporated, and instruments can be provided with 360-deg closed coils. Double brush outputs and special function units are available, as are the standard functions of sine and sine-cosine in the single cup version. —K-10

### Drafting Bow Pens

Two new ultra-hard point bow pens, designed especially for drafting on hard tooth surface materials, have been introduced by Keuffel & Esser Co.

The new additions to the firm's Paragon line are No. 813-H drop bow pen and the No. 816-H standard bow pen each with points made of Carboloy, tungsten carbide.

The pens have stainless steel body construction, nickel silver handles and legs completely free from play, the firm reports. —K-11

### Silicone Grease

A new silicone grease designed as a rust inhibitor and lubricant for mated, threaded, or nonthreaded ferrous components and fabricated rubber parts is now available from the Silicone Products Dept., General Electric Co.

Designated as SS-4007, this compound is said to maintain its consistency from −75 to 300 F and be serviceable in many applications where other products would either solidify, or be subject to oxidation, evaporation, or excessive bleed losses.

The firm says some of the primary applications for SS-4007 include its use as a high and low temperature thread lubricant, corrosion preventive compound, and as a rubber lubricant for low and medium swelling components such as O-rings. It is chemically inert, and protects metals against air oxidation. —K-12

## KEEP INFORMED

BUSINESS NOTES
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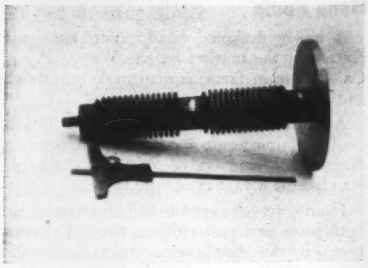

### Titanium Valve Stems

Packless valve stem assemblies with seamless bellows made of titanium, believed to be the first ever made from the light metal, are being produced for a homogeneous reactor project at Oak Ridge National Laboratories by Fulton Sylphon Div., Robertshaw-Fulton Controls Co.

The assemblies are being used in an all-titanium primary reactor loop designed to carry a highly corrosive uranyl sulphate solution at high temperature and pressure.

The firm reports that performance requirements were unusually high for the bellows assemblies. Specifications called for operation at 300 C at pressure of 2500 psig (constant), with $^1/_8$ in. stroke, spring rate not to exceed 1250 lb-in. Outside diameter of the finished bellows in about $1^1/_4$ in. The bellows were made from Grade 55 sheet titanium. —K-13

### Indox V Plate Magnets

Stearns Magnetic Products is now in production on three new models of Indox V plate magnets, designed for installation in chutes, spouts, ducts, or conveyors for removing iron junk from materials in process.

The manufacturer claims the material used in these magnets makes them superior to other metal and ceramic magnets. It is reported to have a superior magnetic field, be impervious to moisture, have unequalled resistance to demagnetization; pound for pound, size for size, costs less. —K-14

### $CO_2$ Welding Process

A new method that uses automatic $CO_2$ welding equipment for field erection of mild steel storage tanks has been announced by Arcos Corp.

The girth seam welding method, as the firm calls it, utilizes a welding process which is a visible arc $CO_2$ shielded automatic process employing a flux-cored wire. A yoke-like frame that supports two wire feed units rides on the top edge of the plate being welded. The two welding units, one on the inside, one on the outside, are offset slightly so that the weld metal deposited by the inside pass can cool before any weld metal is deposited on the outside to complete the weld. —K-15


# Bunting makes the "almost impossible" bearings and parts

The photograph shows a sintered bronze bearing used in an exceedingly popular home laundry drier. It offers several unusual features, some of which you may find useful in designs you are considering as sintered parts. In the first place because the splines on the O.D. of the bearing abut the back of the bearing flange, this is a part which would be almost impossible to produce by machining but can readily be produced by powder metallurgy.

Second, the splines do not extend the full length of the bearing but the density of the splines must be the same as the remainder of the bearing. This requires intricate and unusual tooling and understanding of the problem which is one of the reasons why this manufacturer put his design in the hands of Bunting.

For the unusual, as well as the usual, in bearings, bushings, bars and special parts of cast bronze, sintered metals or Alcoa aluminum, see Bunting first.

**BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.**

*...ask or write for your copy of*

**Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.**

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# Good Pair to Know!

Chances are you won't have to look far to find a spot for one of these float-operated switches.

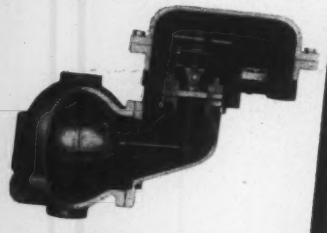
They have been specially developed by McDonnell to serve two broad fields of application. They answer a lot of operating problems that you may have thought could be handled only by make-shift or much more expensive equipment.

Dependable and time tested, they are just two of hundreds of products developed by McDonnell for liquid level or liquid flow control. When you choose from the complete McDonnell line it's good to know you draw on unmatched experience and know-how in this specialized field.

## McDonnell No. 65
### Explosion Proof Electric Controller

***Underwriters' Listed for use in hazardous locations:***
***Class 1, Group C & D***
***Class 2, Group F & G***

A float-operated switch for use under hazardous conditions, such as atmospheres containing butane, benzol, lacquer solvent, alcohols, acetone, coal and grain dust, etc. Can be furnished to make or break electric circuit at high- or low-level — to control motors, signal lamps, electric elements, etc. Suitable for internal pressures up to 40 psi.



Write for McDonnell Engineering Bulletin ERS-10 which discusses typical applications of No. 65, shows wiring diagrams for different patterns of operation.

## McDonnell No. 80
### High- or Low-Level Switch

***Underwriters' Listed for use on oil tanks.***

A float-operated three-terminal switch that can be used to provide high- or low-level alarm, or to start or stop a pump when level rises or falls. It makes possible reliable automatic control in place of gauge glass watching and manual control.

Write for McDonnell Engineering Bulletin ERS-9 which shows typical application of No. 80 on oil storage tanks, complete with wiring diagrams for draining or filling tanks, high- or low-level alarm, signal or cut-off.

***Write for complete literature and engineering bulletins.***

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## Hand Pump

A newly designed hand pump has been placed on the market by the Wayne Pump Co. for use in farm, agricultural, industrial, and general service applications.

According to the company, the DD-1, double action pump has special composition diaphragms and valve parts that enable it to handle a variety of liquids.

Fluids are drawn in and discharged on both push and pull strokes, where it passes between the diaphragms from the intake port at the bottom to a discharge spout or hose assembly on the top. The pump itself has no frictional wear points except the shaft bearing, which is completely isolated from the liquid being pumped. The shaft is stainless steel and the bearing is a special heavy duty nylon type.

The double diaphragms are equipped with integral O-rings which provide a positive leakproof seal at the edges of the pump body. The overall design eliminates the need for priming, the firm states. —K-16

## Speed Control Valve

The Cub, a low cost, lightweight speed control valve, is now available from Ross Operating Valve Co.

Available in $\frac{1}{8}$ and $\frac{1}{4}$ in. pipe sizes, the unit offers a metering adjustment which permits five full turns from closed to full open position. It has short installation radius and small envelope dimensions and is designed to handle 0 to 150 psig air service. —K-17

## Portable Rotary Compressor

Ingersoll-Rand has announced a 125-cfm Gyro-Flo portable rotary compressor, said to be smaller and more compact than the original Gyro-Flo 125.

The new unit incorporates many of the firm's original design features plus new features.

Some of the features listed by the manufacturer are simplified, more efficient compressor system, automatic drainage of oil from cylinders when unit is shut down, larger, more powerful engines, slower speed, safety shut-down on compressor, provision for inspection of all rotor vanes, fuel and air tanks under housing and lockable cover, fold-back, side covers, full-length tool boxes with more storage capacity, and 60 in. track for greater stability on rough terrain.

The new portable is 10 ft, 1 in. long, including drawbar, 5 ft $1\frac{1}{2}$ in. high, 5 feet $8\frac{3}{4}$ in. wide and weighs 2442 lb.

Power for the new 125-cfm size is supplied by 1800-rpm Continental Red Seal engines—either gasoline or diesel. It is available with 2-wheel mounting or less running-gear for truck or skid mounting. —K-18

## KEEP INFORMED

BUSINESS NOTES
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### Flanged Bearing Units

Sealmaster Bearing Div., Stephens-Adamson Mfg. Co., announces LF three-bolt and LFT two-bolt flange bearing units.

The regular L bearing cartridge with spherical OD is permanently mounted in the one piece malleable housing which provides maximum strength with light weight. The company says design of the housing permits either flush or recessed mountings for maximum application flexibility and desired shaft extension with minimum overhang. Housing also provides full housing contact under bearing ball path.

Precision self-alignment takes place automatically between the spherical OD of the bearing and the spherical ID of the housing. Centrifugal-labyrinth seals retain the lubricant and prevent the entry of dirt. Race-to-shaft lock is provided by two cup point set screws. —K-19

### Speed Reducers

Ohio Gear Co. has announced the introduction of a new line of fin and fan cooled speed reducers.

Known as the Hi-Line series, the new reducers feature specially designed external cooling fins plus a powered cooling fan to provide 50 per cent more capacity with no increase in size or weight.

The firm says the new speed reducers use heavy duty worm and gear reduction and also feature heavy capacity bearings, shorter center distance between worm and gear and improved heat dissipation characteristics. —K-20

### Air Conditioners

An improved line of American Blower low pressure inductor air conditioners for application to perimeter areas of multi-room buildings using conventional ductwork is now available from American Standard Industrial Div.

Inductor units provide heating, humidification, cooling, and dehumidification for the perimeter areas of office buildings, laboratories and various other multi-room structures that require relatively large volumes of air for ventilation. The line is available in five unit sizes: 20, 28, 36, 48, and 60—the numbers designating tube length of the secondary coil in inches. Up to 700 cfm of fresh air can be supplied by each low pressure conditioner, the firm reports.

Individual room control of primary air is provided by a standard indexing and locking device for fixing unit volume. This control can be field set as required. It also can be manually operated through a remote control arrangement if desired. The secondary coil, either hot water or steam, can be controlled manually by a hand valve from the standard access door. Automatic electric or pneumatic control valves can be used. —K-21


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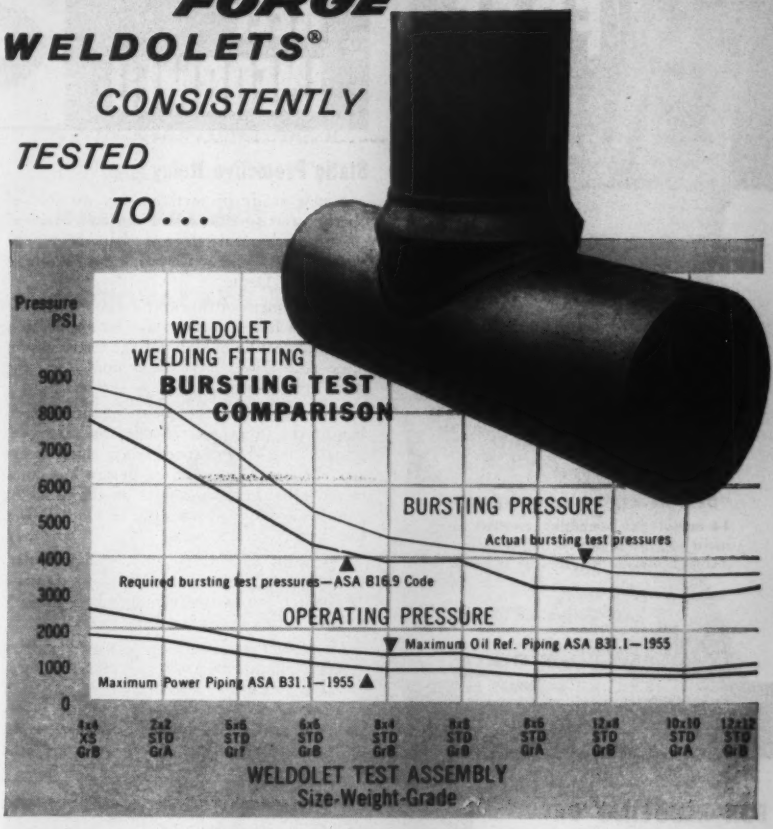


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4½ TIMES MAX. OPERATING PRESSURE

"Shape of Reinforcement"—has been pioneered by Bonney for the past 20 years. The fact that shape is as important and even more important than area replacement for branch reinforcement is now gaining wide industry recognition. Even though Weldolets *do* have sufficient area replacement, the factor setting them apart from conventional lap type reinforcement is their SHAPE... Reinforcement close to the juncture—completely bonded homogeneous reinforcement avoiding cracks, fillet welds, and re-entrant corners—reinforcement tapering at the sides to prevent abrupt change in thickness where fitting joins header pipe.

Recent design improvements in the Weldolet line, based on extensive stress analysis, tests, provide all these desirable "shape" factors. Specify and use Weldolets for all your full size and reducing branch connections. They are available in carbon steel and all alloys for any piping service.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

## Static Protective Relay

A new static protective relay capable of operating at speeds faster than conventional electro-mechanical designs has been announced by General Electric's Low Voltage Switchgear Dept.

Development of this unit is the first in the firm's new line of static relays for application in the protection of high voltage transmission lines and power system components, the company reports.

Believed to be the most significant advancement in protective relaying since the introduction of high-speed relays thirty years ago, the new transistorized design has completed exhaustive field tests on the Muskingum-Philo 138 KV line of The Ohio Power Co.

Operating within one and one-half cycles, the new static relay greatly reduces damage caused by line faults and improves stability to give better system protection.

Designed for use with transistorized carrier current equipment, the relay provides high-speed simultaneous tripping of transmission line breakers for all internal faults by comparing phase relationships of currents entering and leaving a line section. **—K-22**

## Liquid Level Indicator

Yarnall-Waring Co., announces a new miniature secondary liquid level indicator that will duplicate readings from a primary liquid level indicator or differential pressure transmitter anywhere in the plant.

The new indicator is similar to the firm's standard electronic secondary indicator, but is about one-quarter the size. The firm states that the outstanding feature of the miniature design is the substitution of a transistorized amplifier in place of the vacuum tube design in the full-size model.

Weight of the completely integrated miniature indicator is approximately 5 lb. Face dimensions are $2^1/_2$ in. wide by $6^1/_4$ in. high.

It is recomended by the company for instrument panels where fluid lines under pressure are undesirable, for remote locations where distance precludes use of pressure tubing, where freezing may be encountered, and where installation is far above actual liquid level. **—K-23**

## Automatic Pumping Controls

Synchro-Start Products, Inc. has designed a new automatic control especially for use on oil wall, underpass, and pipe line pumping.

The unit is a program timer control for use on gas, gasoline, or diesel engines. It is encased in a steel, weather proof enclosure. The control includes one of the firm's standard automatic engine controls together with a timer driven by a governed d-c motor.

All current is taken from the engine battery so that no commercial power is required for their operation. Variations are available, including safety protection for all abnormal conditions. **—K-24**

## Machinery Spring Mount

A new machinery mounting, incorporating steel springs as the vibration-and-shock absorbing medium, has been developed by Korfund Co., particularly for application where noise is as great a problem as vibration.

Designated the Type LR mounting, a unique feature is its all rubber housing which prevents the transmission of structure-borne high-frequency disturbance and noise. The mount is primarily intended for use with fans, cooling towers, furnaces, piping, packaged air conditioners, air handling units, turbines, motor generator sets. The firm says it is equally effective in protecting machine tools, instruments, and precision equipment from vibration and shock generated by other apparatus.

The mounting can carry loads ranging from 150 to 1400 lb per isolator. It has a minimum operating height of 4 in. Opposed S-slots in the base of the unit permit it to be removed from an installation simply. **—K-25**


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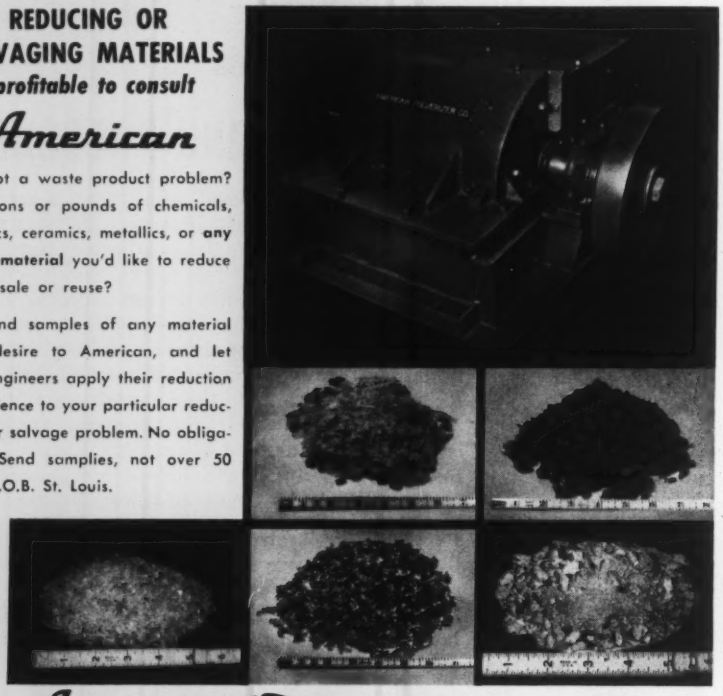

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BUSINESS NOTES
NEW EQUIPMENT
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## Magnetic Separator

A new compact Magnaflo separator unit for the automatic removal of ferrous solids from cutting oils and other soluble coolants is now available from U. S. Hoffman Machinery Corp.

According to a descriptive brochure just released, the separator is fully automatic, operates without attention and is virtually free of maintenance expense for the life of the equipment. Self-cleaning, it eliminates the need for sump cleaning, changing of filter paper, bags or catridges, and delivers near dry sludge for easy disposal. **—K-26**

## Gasketing Material

A new gasketing and mold release material said to combine the best features of aluminum and Teflon has been developed by American Machine & Foundry Co. Commercial Development Div.

The material has such applications, according to the company, as a separator and mold release film for the plastics industry, as an extra-thin gasketing material, and as an insulated flat conductor in electronic components.

Called AMFoil, the new product consists of aluminum foil with Teflon resin cast on one or both sides then fused at 900 F to form a permanent bond. Foil thicknesses range from .0002 to .012 in. and the Teflon coatings range from .00006 to .001 in. **—K-27**

## Ductile Gate Valves

Ohio Injector Co., is producing for first shipments a new line of ductile iron gate valves in $^1/_2$ to 2 in. sizes.

The newly designed valve is said to be the first to utilize all of ductile iron's unique properties and specific design advantages. The firm says consistently high quality castings are assured through strict controls and exacting ductile iron foundry procedures. The valve, listed in the company's specifications under the name Pipe-Pal, is rated at 1000 psi for all temperatures from −20 to 650 F. **—K-28**

## Magnet D-C Motors

Cramer Controls Corp. announces its Type 810 d-c motors of permanent magnet design, combining high torque output at high speeds in a unit of extremely small size and light weight.

They are available for operation on any specified d-c voltage between 3 and 30 v, with armatures wound to produce any desired no-load motor speed between 5000 and 20,000 rpm at the specified input voltage.

Locked-rotor (maximum) output torque for the motor without gear train is approximately 0.7 oz-in., with working torques in the range of 0.5 to 0.1 oz-in. between the output speeds of 5000 and 15,000 rpm. Internal gear trains are available for higher torque at reduced output speeds. **—K-29**


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*With Allis-Chalmers Valves*

**BALL VALVES**
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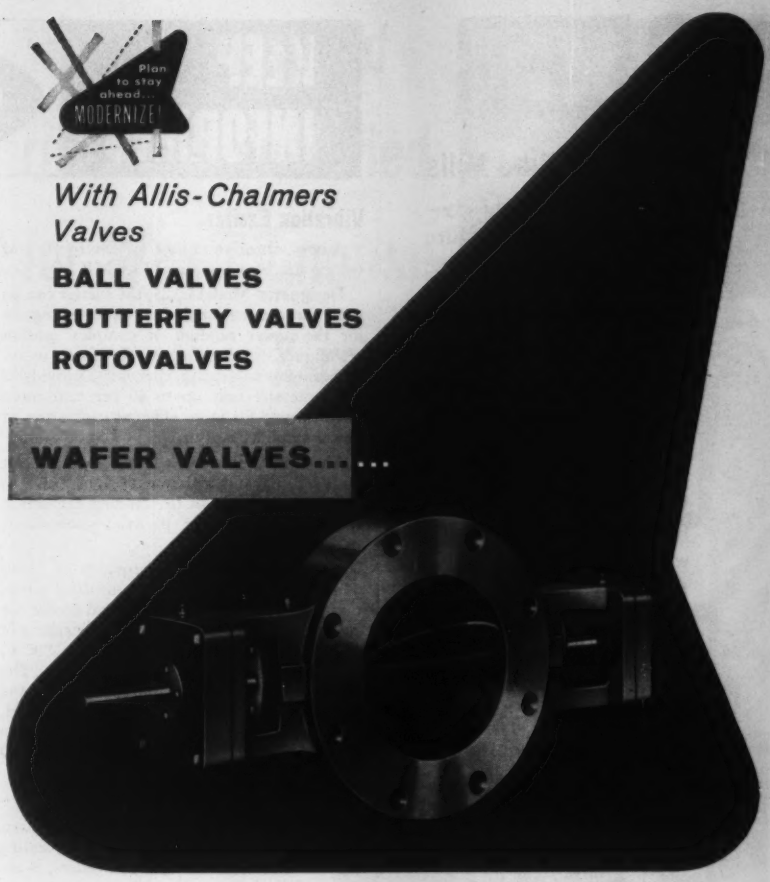
**ROTOVALVES**

**WAFER VALVES.....**



Here's a new wafer valve—with Allis-Chalmers full-bodied design—that incorporates many of the highly-desirable features of two-flanged butterfly valves.

***Rugged Construction***—A-C full-bodied design affords full protection; there is no chance of cracking around bolt holes. Vanes are pinned to stainless or monel shafts with high-tensile pins. Oversized outboard roller bearings and retaining plates are used. Rugged standard mounting brackets provide maximum support for any operator in any position.

***Flexibility***—Valves can be provided in a wide variety of alloys to handle all types of fluids and semi-solids over a wide temperature and pressure range. They may be equipped with almost any operator, which may be mounted in several positions on standard A-C bracket assemblies.

***Through Rubber Seats***—Full rubber seats on A-C Wafer Valves afford maximum body protection and positive, bubble-tight shutoff. Standard seats are of natural gum rubber, neoprene or hycar. Other materials are available on request.

***Size Range***—Full-bodied A-C Wafer Valves are available in standard sizes from 3 to 36 inches in both 125# and 150# A.S.A. series, rated as shutoff pressure of 50# and 125#.

For information on the complete line of Rotovalves, and butterfly, ball and wafer valves, contact your nearest A-C valve representative, or write Allis-Chalmers, Hydraulic Division, York, Penna.

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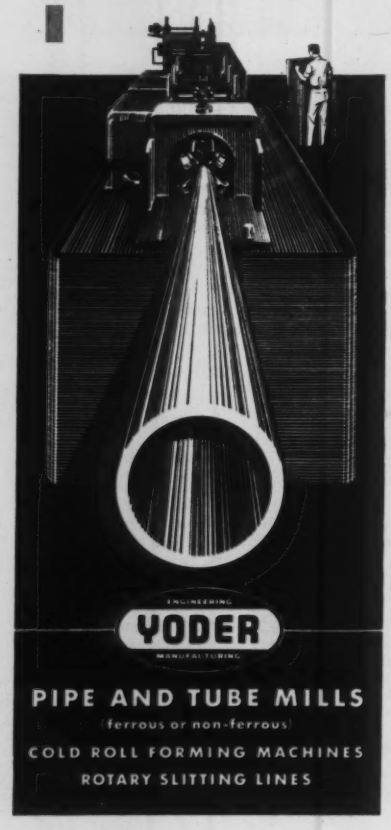


# KEEP INFORMED

NEW EQUIPMENT
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## Vibration Exciter

A new vibration exciter for environmental testing has been announced by MB Mfg. Co.

Designated Model C125, the exciter can be used for conventional sine wave testing, or for the newer random or complex motion techniques. According to the firm, it incorporates a new design concept to provide in the same size unit up to 40 per cent more force output for more efficient utilization of power amplifier output.

The new exciter has a vector force output of 10,000 lb, and a frequency range of 5 to 2500 cps. Weight of the moving element is approximately 100 lb; its axial resonance is well above 2500 cps.

Unimode suspension provides a 1-in. double amplitude for continuous duty vibration testing. The exciter is liquid cooled for environmental test chamber applications in ambient temperatures from −100 to 300 F, and at altitudes up to 250,000 ft. The mounting hole pattern for the table is the same as for previous MB models C25H, C25HB, and C70, permitting use of existing jigs and fixtures. **—K-30**

## Placing Machine

A new, completely automatic parts orienting and placing machine, incorporating three standard vibrating parts feeders, is announced by Syntron Co.

The machine is said to be capable of orienting, feeding and placing components, such as plastic bottles, at a rate of 40 per minute. It is designed to make possible the handling of three sizes of the same bottle with only minor adjustments.

The firm says modifications can be made to adapt the system to different operating speeds and to the handling of a variety of similar type items to automate various industrial processing and packaging operations. **—K-31**

## Irrigation Pipe

Commercial availability of H-E irrigation pipe, a new thick-jointed aluminum pipe said to eliminate a major cause of irrigation-system failures, is announced by Reynolds Metals Co.

The firm says the seamless pipe provides extra thickness, hence extra strength, at the ends, so that they will not be torn or otherwise weakened by bolted, welded or riveted couplings. **—K-32**

## Relief Valves

Cash-Acme Automatic Valves announces a new series of temperature pressure relief valves for water heaters.

Designated Type NV series, the valves feature a new patented thermostatic element, with no fluids to leak out and are said to automatically close tightly after relieving because of temperature or pressure increase.

They are available with or without test levers, with or without 6 in. stems, and in $\frac{1}{2}$ or $\frac{3}{4}$ in. male inlet connections. Valves are AGA listed, and available with relief settings from 50 to 200 psi. **—K-33**

## Double Lap Flarer

Parker Fittings & Hose Div., Parker-Hannifin Corp. has introduced a pneumatically operated machine for forming a double lap flare on the end of ferrous and nonferrous tubing.

The machine handles tubing of $\frac{1}{8}$ through $\frac{1}{2}$ in. OD with wall thicknesses of .028, .035, .042, and .049 in. Punches are available for either the JIC standard 37-deg flare or the automotive 45-deg flare.

The flaring assembly is supported by a floor mounted steel cabinet. The external air supply is introduced through a crown air filter, oil lubricator, and pressure regulator. A three-position control lever simultaneously selects the proper control valve position and operation to be performed by the power head.

This unit positions and clamps the tubing, upsets the end, and double lap flares it. The machine is approximately 4 ft high and weights 285 lb. Operating pressure is 70 to 120 psi. **—K-34**

## Right-Angle Head

Western Gear Corp. Industrial Products Div. announces availability of a universal-mounted right-angle head adaptable for use on the company's StraitLine speed reducers and gearmotors.

The right-angle attachment can be furnished in horizontal, vertical or intermediate positions with single or double extended shafts. It features spiral bevel gearing precision cut from alloy steel forgings and case hardened for maximum strength and durability. Each set of gears is matched and lapped after hardening to insure precise contact and quiet operation. **—K-35**

## KEEP INFORMED

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### Thyratron Tubes

Two new thyratron tubes, WL-7306 and WL-7307, used for general purpose control and welding control service are now available from the Westinghouse Electric Corp.

In addition to xenon filling which minimizes tube voltage drop, each tube has a rugged button stem designed to assure immunity from mechanical failure, the firm reports. Special glass, particularly adapted to automatic sealing machine techniques, is used.

To minimize grid current, a special carbonized nickel grid is employed. High alumina ceramic insulators are used throughout the tubes to insure strength and high insulation resistance. —K-36

### Pipe Line Strainers

A line of newly-designed, single-basket pipe line strainers has been developed by Schutte and Koerting Co.

They are available in 2, $2\frac{1}{2}$, 3, 4, and 6-in. sizes, all with flanged connections. The rating is 125 psig working pressure (cold). Cast iron is used for bodies and covers. A ductile iron quick-opening cover clamp is provided on all sizes except the 6-in., which has a bolted-on cover.

Standard basket construction is stainless steel plate with $\frac{1}{8}$-in. perforations. The ratio of basket free area to cross-sectional flow area of the strainer connections is five to one. For fine straining, baskets are available lined with fine mesh stainless steel screens, in which case the support baskets have $\frac{1}{4}$-in. holes.

Sealing of the basket to the strainer body is accomplished with compressive force applied by the body cover through the basket handle. —K-37


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# Winsmith speed reducers specified for Westinghouse Fluoradex X-ray tables . . .

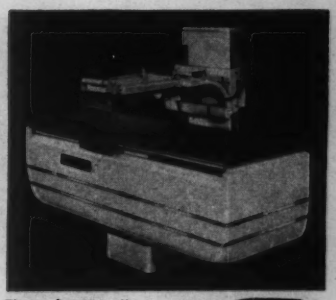

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Table is tilted by precision linkage mounted on a multiple sprocket, chain-driven through a compact Winsmith Differential Reducer.

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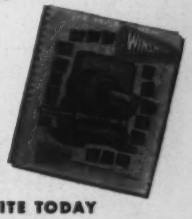

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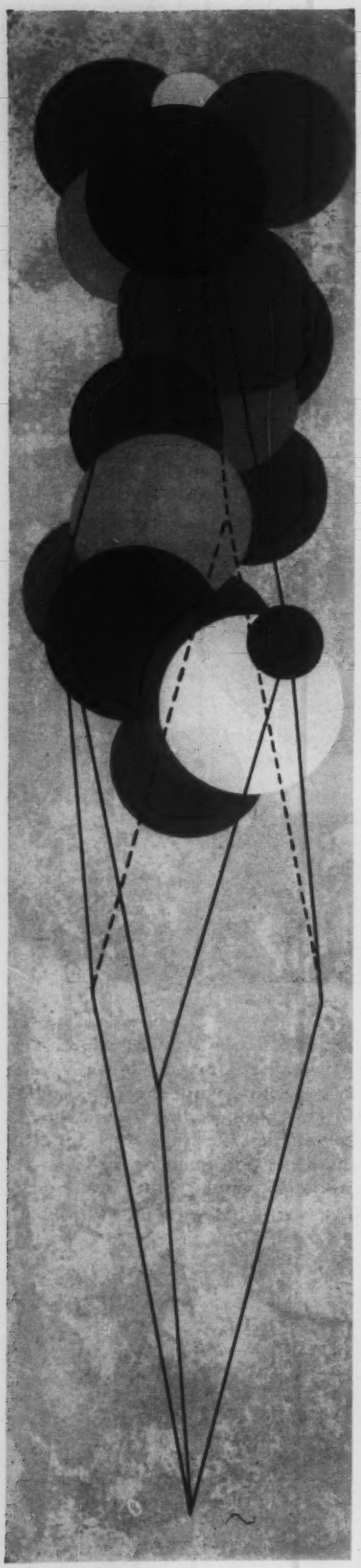

Opportunities in

# Engineering Analysis

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A fast-growing backlog of major projects is creating future-assured openings for qualified nuclear scientists and engineers at Atomics International headquarters in the suburban San Fernando Valley near Los Angeles. AI is now developing a Sodium Reactor power station for Consumers Public Power District of Nebraska and an advanced type of power reactor for a group of fifteen utility companies in the Southwest. Overseas, five AI research reactors are in operation or under construction—and AI's Organic Moderated Reactor is one of the three power reactor concepts the Atomic Energy Commission has approved for export to Euratom.

Here are some typical current openings:

**Reactor Engineering.** Analysis and design of over-all power reactor systems and components. Prefer power reactor background in engineering design and analysis. Experience in reactor safeguard analysis also valuable.

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# KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

## Rigid Vinyl Valves

Addition of 3 sizes ($1/4$, $3/8$, and $1\,1/4$ in.) to its line of rigid polyvinyl chloride Y-globe valves, check valves, and strainers, is announced by Walworth Co.

The products resist inorganic salts, alkalis, acids, and other corrosive fluids used in food, petro-chemical, chemical, pulp and paper and allied industries. The units operate successfully at pressures to 150 psi at 75 F, the firm reports. **—K–38**

## High Speed Bender

A new type of bending machine with two independent bending heads is now available from Costello Engrg. Co.

To operate the machine, a tube is laid into the clamp dies. The operator presses a foot pedal and automatically the form dies swing forward, lock into bending position, and clamp the tube. As soon as the form dies are locked into position, the bending arms automatically rotate to predetermined bend angles.

The operator releases the pedal, and the cycle reverses. The arms return, and the form dies retract, freeing the tube from the dies so it can be removed.

The unit will make bends two at a time or singly. For bending two at a time, the length between centers of the bend radii is adjustable from 7 to 28 in. Each bend angle is independently adjustable from 0–100 deg. The machine bends any size tube up to $3/4$ in. OD steel tube. The shaft journals are made of hardened and ground steel running in hard steel bushings.

All moving parts are protected by an automatic oil-mist lubricator. Standard equipment includes an air filter, regulator, and pressure gage. Dies are made of steel, hardened and ground. Both standard and special die sizes are available. **—K–39**

## Bundling Chain

A new bundling chain, equipped with a drop-forged automatic locking device and fabricated with one end of the chain permanently fastened to this lock, is announced by American Chain Div., American Chain & Cable Co.

In locking operations, the free end of the chain assembly is put through the housing and a grab hook on the dropper chain pulls the chain tightly around the bundle. The hook's latch automatically falls in between the links, locking the bundle securely.

In unlocking, the chain is again engaged by the grab hook and lifted, allowing enough slack in the chain for the latch to be flipped over. When the bundle is set down, the chain is run through the housing, automatically releasing the load.

The lock is made in two sizes. The larger, weighing 7 lb, is used with $1/2$, $9/16$, and $5/8$ in. chain. A smaller lock, weighing 2 lb, is used with $5/16$ and $3/8$ in. chain. **—K–40**

## Air Compressors

A line of air compressors for automotive and industrial applications has been introduced by Lincoln Engineering Co.

The new compressors, of the reciprocating type, are available in more than 200 models, with motor or engine capacities from $1/4$ to 20 hp, air displacement up to 92 cfm, and tank capacities up to 200 gal.

Both horizontal and vertical mounted tank models are equipped for automatic start and stop operation; horizontal models also offer continuous service operation. The firm states that all models are loadless starting; the motor is allowed to attain full speed before compression starts.

Other construction features of the new compressors include lightweight, perfectly balanced 4-ring automotive type pistons; drop forged balanced crankshaft of high carbon steel; Lynite connecting rods; oversize main roller bearings; rotary or piston type oil pump for constant lubrication; high-strength nickel/iron cylinder and head; all models finsihed in high-gloss, hammered copper enamel. **—K–41**

## Preassembled Fastener

A new preassembled fastener which combines a spring washer with a hex nut has been developed by Reliance Div., Eaton Mfg. Co.

Named the Tenz-Nut, this new metal fastening device combines a spring washer with a standard hex nut in a single unit which can be hopper fed on automated assembly systems. Reactive spring pressure is achieved by use of a cupped-type washer.

The spring washer is free to turn, yet it is firmly attached to the nut and will not come off, the firm states. **—K–42**

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*Bulletin No. 31-A*

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## PIPE EXPANSION

PROBLEMS"

TODAY there is an easier way to accommodate *thermal expansion* in piping! No need to install special devices—in virtually every instance, you can put *flexibility* right in the line itself with standard BARCO BALL JOINTS:

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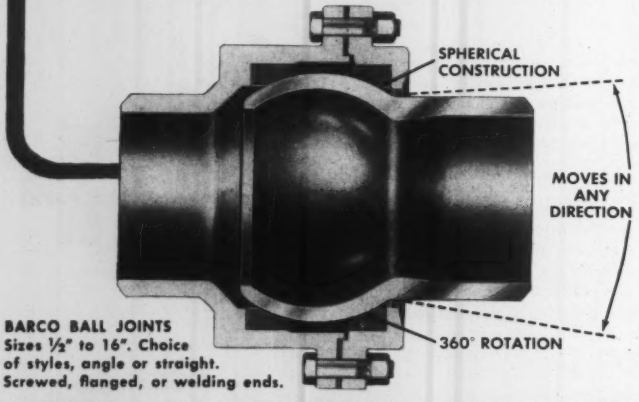
SEE your Barco Representative for information or write. Ask for the new revised Bulletin No. 31-A, "How to Solve Piping Flexibility Problems." *Engineering recommendations on request.*

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# KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

## Frost Proof Faucet

A new frost proof silcock has been announced by Buckeye Valve & Mfg. Co.

The faucet has a patented swivel-seat designed to eliminate grinding seat wear, thereby eliminating leaks and frequent repairs. The unit has a packing nut which prevents leaks through the valve stem and has an extra large waterway for efficient operation.

The extended hose connection eliminates the danger of skinned knuckles when attaching the hose, the firm says. The faucet is available in both threaded and copper sweat types and can be used with both $^1/_2$ and $^3/_4$ in. size pipe and tubing. **—K–43**

## Explosion-Proof Switch

A new enclosed switch listed by Underwriters' Laboratories as being raintight as well as explosion-proof has been introduced by Micro Switch, Div. of Minneapolis-Honeywell Regulator Co.

Catalog listing 2CX3 has aluminum die-cast housing and dome cover. It is designed for use on fuel handling equipment, rocket and missile launching devices, industrial valve control systems, and other hazardous outdoor installations.

Underwriters' Laboratories lists the switch as being suitable for use in Class I (vapor-air mixtures)—Groups C and D; Class II (dust-air mixtures)—Groups E, F, and G.

Electrical capacity is UL listed at 20 amp, 125, 250, or 460 v-a-c. The 2CX3 also is capable of undergoing a 100-hr salt fog test without injury to the actuating mechanism or precision swtiching units.

There is a ring-type seal on the actuator shaft and between the cover and case, and the stainless steel lever arm actuator has a nonsparking roller. The arm is field adjustable through 360 deg and from 1 to $3^1/_2$ in. in length.

Contact arrangement consists of two single-pole, double-throw replaceable switching units. The roller arm is moved clockwise to actuate one unit and counter-clockwise to actuate the other unit. Another design is available which actuates both units when the arm is moved in either direction.**—K–44**

## Integrating Gyros

Kearfott Co., has announced availability of a new series of high-accuracy miniature floated rate integrating gyros designed specifically for use in missiles or severe missile-like environments.

The units are 2 in. in diameter and $2^3/_4$ in. long, and consist principally of a gyro motor, a torque motor, a signal generator and a constant damping device. The design combines the torque motor and the signal generator in a single unit, or torsyn, together with a restraint-trimming tertiary winding. **—K–45**

# Need more engineering information on products featured in this issue?

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**MECHANICAL ENGINEERING—JUNE 1959—Products Advertised**

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|---|---|---|---|---|---|---|---|---|
| 1 | 17 | 32 | 43 | 160 | 175 | 186 | 201 | 221 |
| 2 | 18, 19 | 33 | 44, 45 | 161 | 176TL | 187 | 202 | 223 |
| 4 | 20 | 34 | 46 | 162TL | 177 | 188 | 203 | 225 |
| 6 | 21 | 35 | 47 | 162BL | 178L | 189 | 207TL | 230 |
| 7 | 24 | 36 | 48 | 163 | 179 | 192 | 207BL | IFC |
| 8, 9 | 25 | 37 | 153 | 164 | 180 | 193 | 207R | IBC |
| 10, 11 | 26 | 38 | 154 | 165 | 181 | 194 | 208L | OBC |
| 12, 13 | 27 | 39 | 156 | 168 | 182L | 195 | 208R | |
| 14 | 28, 29 | 40 | 157 | 171 | 182R | 197 | 209L | |
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| K-2 | K-13 | K-24 | K-35 | K-46 | K-57 | K-68 | K-79 | K-90 |
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# KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

## Nozzle Gas Burner

A new burner developed for heating processes requiring sealed-in firing with any commercial fuel gas is announced by Hauck Mfg. Co.

The company reports that lighting is positive at any burner setting on hot or cold furnaces, kilns, or retorts. Combustion is said to be more quiet than with premix burners and the high forward velocity of the combustion gases produces greater heat distribution.

Since the air and gas mix at the burner outlet, there is no flashback, the firm states. Proportioning mixers are eliminated. In this burner design, the gas streaming through the center is surrounded by a guide cylinder of air, igniting to produce a uniform fire in the burner tile, without causing excessive tile temperatures. —K–46

## Switching Control

A new control for capacitor switching is now available from the Westinghouse Electrical Corp.

Enclosed in a Flexitest case, the new control contains an improved master induction disk relay which has a dual range of adjustment—from $\frac{1}{2}$ to 1 amp and from 1 to 4 amp. A var relay is used for the first time, the company reports.

Two thermal plug-in-type fixed time-delay relays, one in the close circuit and one in the trip circuit, provide a predetermined time delay to eliminate unwanted switching operations from rapid system fluctuations of short duration. The fixed time-delay relays are in the circuit only during automatic operation.

To keep the capacitors connected and prevent unwanted switching operations, a new toggle relay is used. With this new relay, Type SX, the oil switches remain closed and the capacitor bank remains connected when voltage is restored.

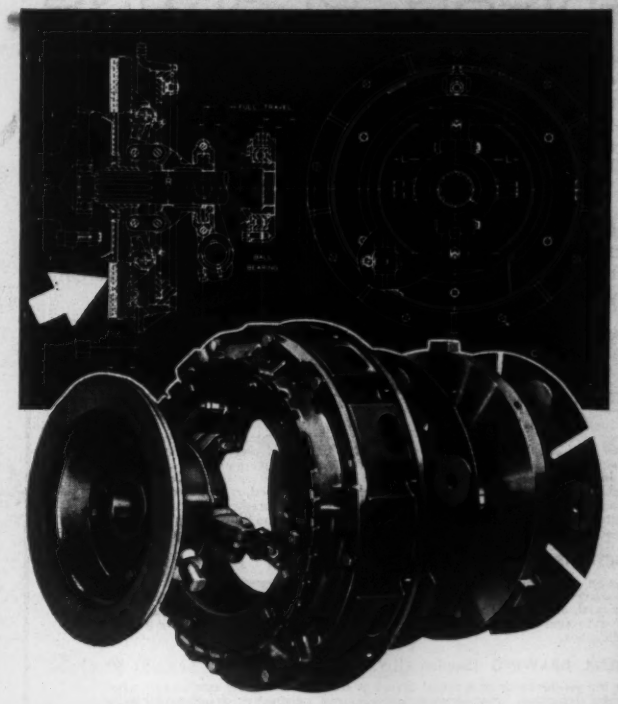
A low-voltage lightning arrester has been added to protect the circuit elements from voltage surges. —K–47

## Atmospheric Filters

A new line of filters with an efficiency of 95 per cent on 0.3 $\mu$ particles and of 99 per cent by the discoloration test using atmospheric dust, has been announced by the Cambridge Filter Corp. Known as the Micretain series Absolute filter, it is claimed to offer extremely high efficiency at an initial pressure drop of only 0.4 in. w.g. The firm says tests to a final pressure drop of 1.0 in. w.g. using 100 per cent outside air show a service life of at least 4000 hr without the use of prefilters.

The filter medium is encased in a chipboard frame which is self-supporting, and, in assembling the filter bank, the filters are easily stacked, like building blocks. A new glass-asbestos filter medium with Kraft separators provides a capacity of 1000 cfm in a face area of 24 × 24 in. and a filter depth of $11\frac{1}{2}$ in. —K–48


ROCKFORD



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If you have a heavy-duty vehicle in the planning stage, it will pay you to learn about these and other advantages of this new clutch—before you design the drive line. A design study of your present drive lines might indicate advantages of using this ROCKFORD CLUTCH. For information write Dept. D — or

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The Manual is being published in seventeen sections, of which the following are now available. If you are not using them, it will pay you to do so for, with their aid, mistakes can be eliminated, efficiency increased, and the best type of workmanship produced.

**SIZE AND FORMAT (Section 1), Y14.1 — 1957.** $1.00

Deals with sheet sizes, the basic format, location of title and revision blocks, positioning of lists of material and drawing numbers, and print fold. Illustrated.

**LINE CONVENTIONS, SECTIONING AND LETTERING (Section 2), Y14.2 — 1957.** $1.50

Scope: Line symbols, visible and hidden lines, section, center and dimension lines, extension lines and leaders, cutting plane lines, break and phantom lines, section lining on detail and on assembly drawings, direction and spacing of general purpose section lines, the cutting plane, full and half sections, location of sectional views, lines behind the cutting plane, broken-out, revolved, removed, offset, auxiliary, and thin sections, sections through webs, shafts, bolts, pins, foreshortened projections and rotated features, intersections in section, sizes of lettering for different purposes. Twenty-seven diagrams supplement and illustrate the text.

**PROJECTIONS (Section 3), Y14.3 — 1957.** $1.50

Covering arrangement of views for multiple view orthographic projections, this Section describes and illustrates practices in the choice and arrangement of the views, use of partial, alternate, removed and revolved views, auxiliary views, conventional breaks, and rounded and filleted intersections, developed views, descriptive geometry applications.

**PICTORIAL DRAWING (Section 4), Y14.4 — 1957.** $1.50

Here the various kinds of pictorial drawings are defined and the correct method of using them described. Axonometric, oblique, and perspective drawings are fully considered, and a number of examples presented showing the variety of positions in which the axes may be placed. Suggestions are given on the proper pictorial arrangement of sectional views, thread representation, the use of break lines, indicating fillets and rounds, unidirectional and pictorial plane dimensioning, shading, and phantom drawing.

**DIMENSIONING AND NOTES (Section 5), Y14.5 — 1957.** $2.00

Defines terms used in dimensioning drawings, illustrates how dimensions and notes should be used to specify design requirements on mechanical drawings, and includes dimensioning practices for the control and form tolerancing of geometric surfaces.

**SCREW THREADS (Section 6), Y14.6 — 1957.** $1.50

Presents the approved methods of placing screw thread data on drawings and a considerable amount of information on thread tolerances useful to draftsmen. Typical drawing notes are shown along with specific practices for dimensioning.

**GEARS, SPLINES, AND SERRATIONS (Section 7), Y14.7 — 1958.** $1.50

Although this Section is not intended to be a textbook on gear design, it does give reasons for the methods shown and specified, so that the user will have some basic understanding of the need for more detailed gear-tooth dimensioning and specifications. Also included are the delineation and specification of Splines and Serrations.

**METAL STAMPINGS (Section 10), Y14.10 — 1959.** $1.50

Sets forth practices used by small parts manufacturers in the production of metal stampings as produced on standard types of punch presses. Here too, will be found help in laying out and delineating a product which will be subjected to metal stamping processes. References to methods of fabrication, die clearances, etc., are also included, although this type of information is not specified on the production drawing.

**FORGINGS (Section 9), Y14.9 — 1958.** $1.50

This document represents the best judgment produced by years of experience in forging and will supply the needs of the draftsman who must transform a design sketch to a production drawing.

**PLASTICS (Section 11), Y14.11 — 1958.** $1.50

With the increasing applications of Plastics in industry, this Section should prove extremely useful in the drafting room. It gives recommended practices in the representation and dimensional sizes of various features which must be incorporated in drawings.

**FLUID POWER DIAGRAMS (Section 17), Y14.17 — 1959.** $1.50

Contains the procedures to be followed in the delineation of drawings which depict fluid power systems using a fluid (liquid or gas) within enclosed circuits to transmit and control power. Types covered are: Pictorial diagram which may be used for quotation and piping the installation; Cutaway diagram which is most often used for instruction purposes; Graphical diagram which may be used for quotation, piping and installation, and for analyzing circuit operation; and a Combination diagram which is used to emphasize purpose and operation of a portion of a system.

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# KEEP INFORMED

## Metalworking Technique

An unusual new metalworking technique, said to be capable of instantaneously and completely fabricating such complex shapes as faucet handles and the hub and spokes of a steering wheel, is announced by Aluminum Co. of America.

The technique -- lateral impact extrusion -- is a modification of the impact process.

The "lateral" of lateral impact extrusion refers to the direction of metal flow, the company explains. Heretofore, impacts have been produced as a result of metal flow up around a punch, down into a die, or a combination of these.

With lateral impacts, Alcoa says it adds to the process the additional potential of metal flow outwards at any angle from the direction of the impact stroke. **—K–49**

## Vibration Testers

The importance of fatigue testing of prototype pilot models and parts is discussed and eight models of mechanical vibrator testers are described in a bulletin released by All American Tool & Mfg. Co. **—K–50**

## Manual Control Valves

A new line of handwheel operated control valves, designated as Series LM valves, is now available from Conoflow Corp.

The valve features a single-seated valve body with extra thick body walls cast to 600 lb ASA rating. Available in ductile iron, steel, bronze, and many high alloys, it is said to be especially suited to solve corrosion and erosion problems encountered when using hard-to-handle process fluids.

Tight shut-off is claimed through the use of special seat materials such as Teflon. A range of sizes, $^3/_4$ through 6 in. with separable or integral flanges, is available. Micro-flow control is accomplished by the combination of a vernier position indicator, long stroke, and an oversized handwheel. Other features are a fully guided throttle plug for positive alignment, and a lift-out seat ring design.**—K–51**

## Marine Fuel Filter

An all-bronze fuel filter for installation on marine inboard engines has been announced by Purolator Products, Inc.

The new filter, designated Model P11-11, uses a specially-designed paper element to trap and remove tank rust and scale which, when the craft is in motion, breaks up into microscopic particles to cause dangerous carburetor flooding or poor performance.

The element, a resin-impregnated cellulose, removes contaminants as small as one micron. Highly resistant to water and other corrosive agents, the replaceable paper element will not disintegrate or break and clog the fuel system, the firm reports. **—K–52**

## KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

### High Pressure Dryers

For drying gases at elevated pressures (1000 to 6000 psig), the C. M. Kemp Mfg. Co. announces a standardized series of desiccant dryers.

These high pressure dryers are designed to handle air, oxygen, carbon dioxide, argon, helium, and hydrogen; drying to dewpoints as low as −160 F. Current applications are in the fields of missilry, research, and industrial testing. The Series A line is described in Bulletin D-108 which contains performance data, selection, charts, information on high pressure systems engineering. —K–53

### Loader Regulators

Two new series of loader regulators and valves for the firm's Gas-O-Dome regulators and for applications using gases to 10,000 psi, are announced by Victor Equipment Co.

The Model LR20B series loader regulators are designed for low capacity testing (2 scfm) of valves, missile and aircraft components, and for dead-end testing with all high pressure, noncorrosive gases, including oxygen. The firm says they hold outlet pressure without leakage after inlet pressure decays. Bronze models provide maximum inlet pressure of 7000 psi for use with outlet pressures ranging from 5 to 7000 psi. Stainless steel models are available for 10,000 psi service with compatible gases. —K–54

## BUSINESS NOTES

### To Build Hydrogen Plant

Union Carbide Corp.'s Div., Linde Co. will build a liquid hydrogen producing plant at Torrance, Calif. Construction of the plant will be completed in one year.

Original plans called for beginning construction of a liquid hydrogen facility on the west coast late this year. Construction date has been advanced since the National Aeronautics and Space Administration recently awarded a contract for the supply of liquid hydrogen to Linde Co. Under the terms of the contract Linde will supply NASA up to 3,300,000 lb of liquid hydrogen per year.

### Tube Mills Completed

Completion of new $10,000,000 tube mills in New Milford, Conn., representing the latest step in the firm's long-range Mills Div. expansion and modernization program, has been announced by Scovill Mfg. Co.

The New Milford tube mills provide facilities extending the firm's line to include copper tube and pipe for plumbing, heating, and air conditioning applications.


SYNTRON Equipment
of proven dependable Quality

for design problems involving

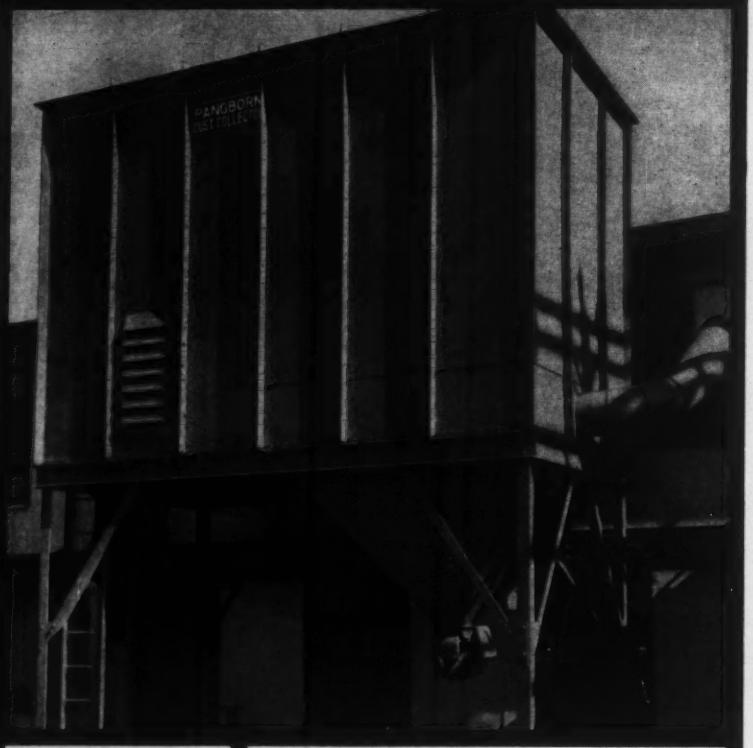
- Controlled Vibratory Motion (Conveying, settling, elevating and agitating)
- Rotary Shaft Sealing
- Power Conversion
- Automatic Parts Feeding

For more than 35 years SYNTRON has been designing, engineering and manufacturing equipment that can also be used as components of other devices — providing a ready-made answer to many problems.

If you are currently designing equipment that can utilize such components, it will pay you to call your nearest SYNTRON representative — or write for free detailed catalog information.

SYNTRON COMPANY
498 Lexington Avenue Homer City, Penna.

# TRAPS ALMOST 4 CU. FT. OF DUST PER WEEK



**One small Pangborn Dust Control system replaces 8 collector units profitably at Precision Rubber Products**

**At Precision Rubber Products Corporation, Dayton, Ohio, millions of seals pass through a buffing process every year. The resulting dust could constitute an operating and housekeeping hazard. To facilitate dust control, the company replaced eight individual collector units with a central Pangborn Dust Control system. This installation saves floor space, operates quietly and gives efficient dust control (trapping almost 4 cu. ft. of rubber dust per week). Dust is now removed from *one* collector hopper instead of eight individual hoppers.**

**If dust is a problem in your plant, talk to the Pangborn man in your area or write PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control and Blast Cleaning Equipment—Rotoblast® Steel Shot and Grit.***

**Pangborn CONTROLS DUST**


## KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

### Moves to Concord

General Radio Co., manufacturer of electronic measuring equipment, is moving its headquarters and remaining personnel in Cambridge to its new offices in West Concord, Mass. The company purchased 80 acres of land in Concord in 1948, on which the first of the present buildings for manufacture were built in 1952. In the spring of 1958, other sections left Cambridge to occupy another addition. The facilities completed this year bring total work space in the modern, well integrated buildings to more than 250,000 sq ft.

### Shipyard Bought

Maryland Shipbuilding & Drydock Co. announces that its wholly-owned and newly formed subsidiary, Charleston Drydock Co., had acquired substantially all of the assets of Charleston Shipyards, Inc., Charleston, S. C.

The Charleston company has operated a ship repair yard under lease from the U. S. Navy for a number of years and has performed a variety of repair work on both merchant and Naval vessels. Transfer of the Navy lease to the new company was part of the acquisition arrangement.

## LATEST CATALOGS

### Heat Exchanger Tube

Scovill Mfg. Co., Mill Products Div., has issued a 6-page bulletin giving technical information on the use of copper and alloy tubes in condensers and heat exchangers.

A table shows the composition of various tube alloys and data is given on specifications, size, and links and the processing of the tube. **—K–55**

### Instrument Components

PIC Design Corp., Subsidiary of Benrus Watch Co. is offering its new, 416-page master catalog, No. 20.

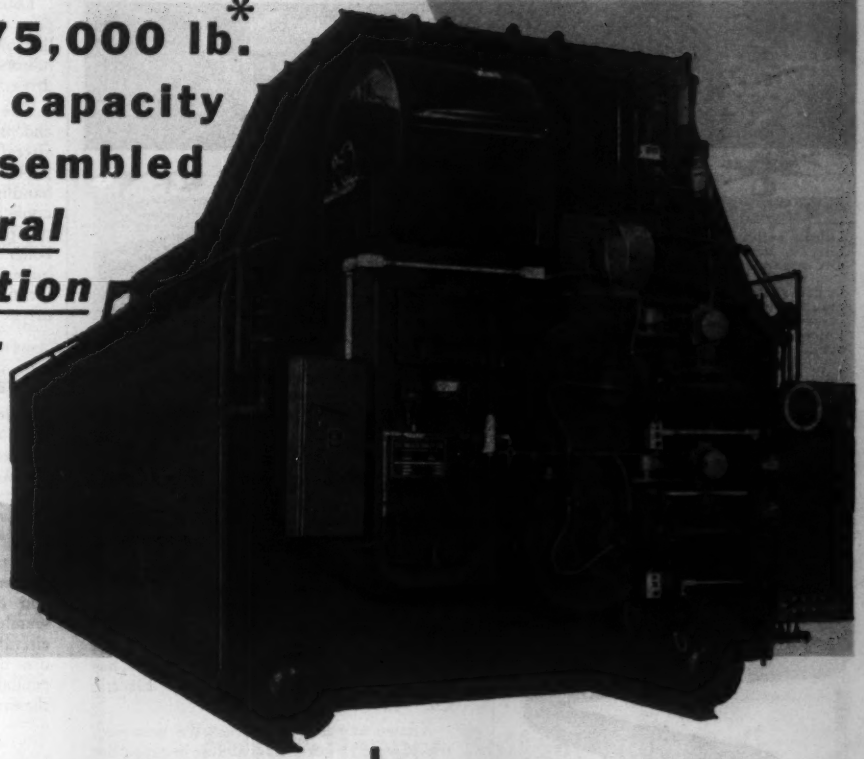
Consolidating all previous catalogs and supplements, the new catalog lists more than 10,000 items, including gears, shafts, collars, couplings, speed reducers, differentials, and other precision items available from stock. In addition to detailed drawings, complete specifications and prices, the new catalog contains separate technical data, breadboard kit and precision tool components sections. **—K–56**

### Load-Packer

Gar Wood Industries, Inc. announces the availability of a full-color, three-page catalog on its new Load-Packer 600 refuse collection unit. A specification sheet is also included. **—K–57**

# ...now from WICKES

## a new 75,000 lb.* per hour capacity shop-assembled *natural circulation* boiler



*75,000 lbs. per hour present capacity.

80,000 lbs. per hour future capacity with economizer

Wickes Type A units are of simple design, ruggedly constructed and adaptable to a variety of operating conditions and may be Oil or Gas Fired.

All units are shipped completely shop-assembled including superheater fuel burning equipment, safety and combustion controls, forced draft fan and drive, soot blowers and feedwater regulator.

**Save on**

- First Cost
- Operating Expense
- Space
- Delivery Time
- Installation Time

For more detailed information on Wickes Type-A steam boilers, write for our catalog 56-1. Bulletin 55-1 covers the complete line of Wickes Products and Facilities.

WICKES

**WICKES BOILER CO., SAGINAW 13, MICHIGAN**

**DIVISION OF THE WICKES CORPORATION**

*RECOGNIZED QUALITY SINCE 1854* • *SALES OFFICES:* Boston • Chicago • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • New Orleans • Portland, Ore. • Saginaw • San Francisco • Springfield, Ill. • Tulsa.

169

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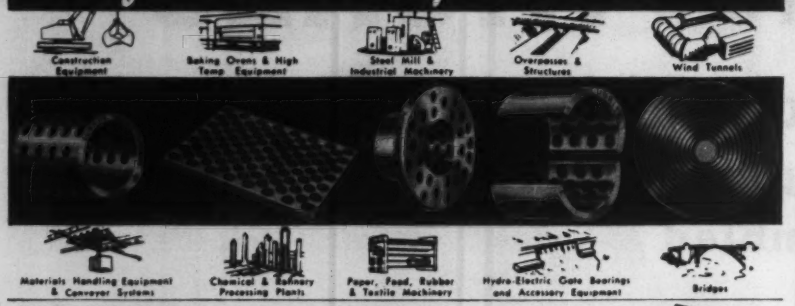
Self-Lubricating BEARINGS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Baking Ovens & High Temp. Equipment
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Lubrite self-lubricating bearings offer great versatility in hundreds of fields where dependability and superior performance are of prime importance.

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Send for this free 20-page Lubrite Manual No. 55—it contains complete information, technical data and specifications about Lubrite Self-Lubricating Expansion Plates and Bushings. Write today!

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FIGHT CANCER
WITH A CHECKUP
*(See your doctor)*
AND A CHECK
*(Send it now)*
TO
AMERICAN
CANCER
SOCIETY

## Heavy Fork Trucks

A six-page folder, illustrating and describing its new line of heavy-duty fork trucks, has been published by Elwell-Parker Electric Co.

Known as the Titan series, the new electric-powered trucks are available in capacities from 12,000 to 20,000 lb. The literature contains detailed engineering information along with dimensions and specifications. A special table compares the features of Titan trucks with similar models. —K-58

## Nongeared Small Motors

An eight-page catalog describes four types of a-c shaded pole, reversible, nongeared motors manufactured by Barber-Colman Co.

Information on performance characteristics, ratings, construction, dimensions and typical applications is given, and a special section covers electronic control of the firm's reversible motor. Duty cycle data, power source considerations, special features, braking and speed control information are included in the catalog. —K-59

## Table Conveyor

A new brochure covering the new Model 1050 Table-Veyor conveyor has been published by Rapids-Standard Co.

Illustrated and explained are applications in both industry and commerce. A complete listing of detailed specifications, including lengths, widths, and working heights available included. —K-60

# KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

## Motors, Drives

Louis Allis Co. has published an eight-page bulletin, No. 2650, that describes its line of a-c and d-c standard motors, special motors, gearmotors and adjustable speed drives.

The bulletin gives information on motors and drives for the machine tool, textile, aircraft, petroleum, chemical, paper and paper converting, air conditioning, materials handling, and metal industries. Individual applications include irrigation, power plant, pump, mixer, agitator, pipeline, municipal, boiler feed pump and test equipment. The bulletin summarizes characteristics and modifications for 20 basic types of motors and drives ranging from 3/4 to 2000 hp. —K-61

## Aircraft Tubing

Ohio Seamless Tube has published a revised version of its technical handbook A-2 which describes seamless aircraft tubing, carbon and alloy steels.

Its 70 pages cover definitions, military and AMS specifications, sizes, tolerances, sampling, testing, packing, marking, machining, heat treating, properties, and mill practices. Information is presented with charts, tables, and drawings where applicable. Aircraft seamless tubing grades are not confined to aircraft and missile applications, but find uses in applications where strength and dependability demand the ultimate in quality, the firm reports. —K-62

## Monel Tubing

The Monel family of small tubing is described in a four-page technical bulletin by Superior Tube Co.

Listed in the folder are the chemical composition, physical constants and mechanical properties of four materials in tubing form: Monel, R Monel, 403 Monel and K Monel. Superior supplies the tubing as both seamless and Weldrawn (welded and drawn). Minimum and maximum production limits on walls for tubing of various outer diameters from .012 to 1.125 in. are listed. —K-63

## Blind Rivets

An eight-page brochure, Form 8-409, describing PT and 9SP blind rivets is now available from Huck Mfg. Co.

The new brochure lists the advantages of the blind rivets and includes such technical information as recommended hole sizes, material specifications, shop practice notes and shear and tension strength values. Typical blind applications are illustrated with cross-section line drawings. It also presents in illustrations the driving cycle (installation sequence) for each type of blind rivet discussed. —K-64

# KEEP INFORMED

## NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

### Laboratory Clamps

A six-page brochure illustrating and detailing new laboratory clamp line is now available from Labasco.

The firm is a nation-wide amalgamation of laboratory supply distributors affiliated for improving customer service and developing new laboratory equipment. The new laboratory clamps are said to be the first major redesign of these essential laboratory implements in more than 25 years. —K–65

### Electronic Air Cleaner

A 16-page product bulletin which describes its Model B Rollotron electronic air cleaner has been made available by American Air Filter Co.

Included are details of operation and electronic principle, an explanation of the agglomerator and storage sections, equipment drawings, capacity and dimension tables, specifications, a list of typical installations and a description of the horizontal version of the unit. —K–66

### Stainless Fittings, Flanges

New Pipe-Mate light-wall stainless steel fittings and flanges for noncritical process piping are described in a six-page bulletin available from Tube Turns Div., Chemetron Corp.

The new line features long tangent fittings, unique rotating insert flanges and a reversible plug-and-cap. Illustrations show different methods of joining light-wall fittings and pipe, including a sequence of photos on making rolled in flanged assemblies. Charts give dimensions of the new line of fittings and flanges, design properties of 5S and 10S pipe and dimensional tolerances. —K–67

### Silicone Products

An eight-page catalog highlighting the company's major silicone products and their uses is available from the Silicone Products Dept., General Electric Co.

Among the silicone uses described are: rubber products, including the new RTV (room temperature vulcanizing) silicone rubber; cosmetics and polishes, electrical insulation, water repellents, textile finishes, lubricants, and release and anti-foam agents. Designated as CDS-129A, the publication lists additional specialized literature covering product and application information. —K–68

**For Consulting Engineers**
**Turn to Page 222**

### Drive Lubrication

A new bulletin on lubrication of roller and silent chain drives, covering principles of lubrication, maintenance and oil selection, is available from Sun Oil Co., Industrial Products Dept. —K–69

### Pipe Data Card

A technical data card published by Tubular Products Div. Babcock & Wilcox Co., contains dimensions and weights per foot of pipe in sizes $^1/_8$ through 36 in. for all schedules. The card is identified as TDC-191. —K–70

This high capacity Amplitrol "packaged" unit bolts directly to the hopper flange. Feeds to conveyors, crushers, screens, blenders, other process equipment.

**"Feeder-Hopper Bottom Package" Reduces Design, Installation Costs!**

For the first time a feeder is offered as part of a complete pre-engineered feeder-hopper bottom package. When you design with Carrier Amplitrol feeders, you merely design a hopper flange to bolt to the packaged unit. *This saves you both engineering design and installation costs!*

This preassembled packaged unit is built around the revolutionary new Amplitrol feeder — first mechanical vibrating feeder with variable, stepless control—and includes the hopper bottom, flanged hopper connection, skirt plates, regulating gate, isolation and suspension supports.

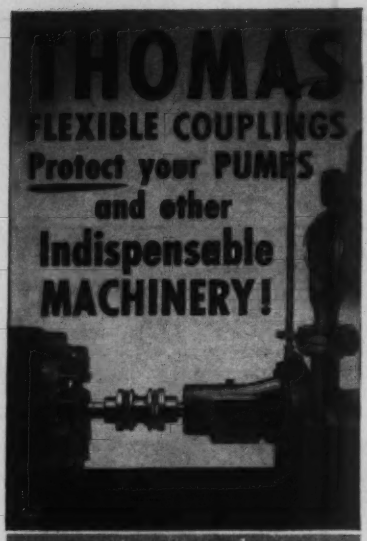
The feeder-hopper bottom unit is offered in two models—one for *high capacity* applications and one for *maximum control.*

Amplitrol's exclusive long-stroke drive handles higher capacities by automatically compensating for headload. This allows larger hopper openings, reduces bridging and hang-up. The simple, fast-responding pneumatic control system operates manually or in automatic response to any standard process instrumentation.

*Send for new Bulletin No. 591 describing Amplitrol "package" in detail. Carrier Conveyor Corporation, 222 North Jackson Street, Louisville, Kentucky.*

**CARRIER**
**"NATURAL-FREQUENCY" VIBRATING EQUIPMENT**
*Engineering Specialists in Vibrating Equipment*

CONVEY ● FEED
DEWATER ● SCREEN
COOL ● AGGLOMERATE
DRY ● SCALP ● COAT
DISTRIBUTE ● ELEVATE
● FLATTEN BAGS




NO LUBRICATION
NO MAINTENANCE
NO WEARING PARTS

Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.
They will protect your equipment and extend the life of your machines.
Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

**UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES:**

- Freedom from Backlash
- Torsional Rigidity
- Free End Float
- Smooth Continuous Drive with Constant Rotational Velocity
- Visual Inspection While in Operation
- Original Balance for Life
- No Lubrication
- No Wearing Parts
- No Maintenance

*Write for Engineering Catalog*

**THOMAS FLEXIBLE COUPLING CO.**
WARREN, PENNSYLVANIA, U.S.A.


# KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

## Bantam Pulverizer

Pulverizing Machinery has released a new bulletin on its Bantam Mikro-Pulverizer, No. 51F-1.

The new literature covers in detail its basic uses in the laboratory, pilot plant, and small batch production. It covers specifications for cosmetic, dye and color plants, pharmaceutical and chemical, bakeries and confectionery, wet milling, and pilot plant operation. Diagrammatic photographs of the unit and grinding chamber parts are included. —K-71

## Quick-Release Pin

General Fastener Corp. announces a new engineering bulletin listing dimensions, specifications, and call-outs for its line of positive locking quick-release pins.

The pins are manufactured in both single and double acting types, with protruding steel ball locking system. Double-acting pins are available in either drive-out or non-drive-out types. They are used in aircraft, maritime, weapons systems, ground handling, transportation, and electronics applications. —K-72

## Vibratory Feeder

Syntron Co. announces publication of a new catalog on Syntron vibrating feeders, designed for finger-tip controlled, low maintenance feeding of hard-to-handle bulk materials.

The 32-page catalog contains descriptions, data, and specifications for the company's complete line of six small-capacity, four heavy-duty, and three extra-heavy-duty standard electromagnetically vibrated feeders. It also presents information on three pneumatic and hydraulic vibrated feeders for explosive materials, dangerous atmospheres or for light, fluffy materials. —K-73

## Fire, Booster Pumps

Allis-Chalmers fire and low pressure (booster) pumps are described in new literature released by the company.

These are centrifugal double-suction, single-stage units approved by Underwriters Laboratories, Inc. or the Associated Factory Mutual Fire Ins. Co. for heads from 50 to 145 psi and for capacities from 500 to 2500 gpm. The pumps can be driven by motor, gas or diesel engines, or steam turbine and are available as an engineered package including pump, motor, and manual or automatic control. —K-74

## Low-Cost Strainers

Bulletin 9S-A, published by Schutte and Koerting Co., describes the company's line of Econex single-basket strainers for medium and fine straining of industrial liquids at pressures up to 125 psig (cold).

The strainers are a newly-designed line available in sizes from 2 to 6 in., inclusive. Cast iron construction is used for bodies and covers. Ductile iron serves in the quick-opening cover clamp. Stainless steel cylindrical baskets with $^1/_8$-in. perforations are standard. Baskets are also made with fine mesh stainless steel screen liners for fine straining. —K-75

## Vinyl Valves

A six-page brochure, No. 601, describing what is claimed to be the first all-molded corrosion-resistant PVC valve ever designed by a valve manufacturer, has been published by Lunkenheimer Co.

The new brochure features a table, giving the manufacturer's recommendations for handling various corrosive fluids, detailed information on sizes, weights, and dimensions of both screwed and socket end PVC valves, and insulation data. —K-76


*Definitions of Occupational Specialties in Engineering*

This book contains comprehensive data related to all activities and specializations in engineering including specific knowledge and duties, responsibilities and related techniques necessary for successful performance in each field.

The ten activity fields defined are research, design, development, testing, procurement, production, construction, operation, administration, and teaching.

Major engineering fields of specialization defined include aeronautical, automotive, ceramic, chemical, civil, electric and electronics, guided missiles, management, marine, materials, mechanical, metallurgical, mining, naval, nuclear reactor, ordnance and armament, petroleum and fuels and power plant engineering. Other engineering fields defined are: packaging, photogrammetry, agriculture, geology, and geophysics.

Pub. 1952 Price: $2.50, 20% less to ASME members.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th St., New York 18, N. Y.

## KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

### Centrifugal Pumps

A catalog describing small centrifugal pumps for air conditioning systems, lawn sprinkling systems, small cooling tower systems and other package equipment is available from the Pump Div., C. H. Wheeler Mfg. Co.

The pumps are the SCC close-coupled type. Typical applications include water circulation, domestic water supply, hot water heating, booster service, and stuffing box water supply for sewage or stock pumps, The catalog contains outline dimensions, design, and material data and performance curves. —K-77

### Heavy-Duty Fans

Mechanical draft and other heavy-duty fans are described in a 28-page bulletin, FD-905, available from Buffalo Forge Co.

The booklet includes basic data for fan selection, performance tables, design sketches, 35 component and installation photos of types ranging from kiln fans to cyclone compressors. —K-78

### Instrument, Control Panels

Details of construction, dimensions, weights, instrument mounting, and accessories for six standard styles of instrument and control panels may be found in new, 16-page Product Specification G71-7, issued by Bailey Meter Co.

Standard procedures for tubing and wiring are presented along with a check list for ordering or requesting quotation. —K-79

### Heat Exchangers

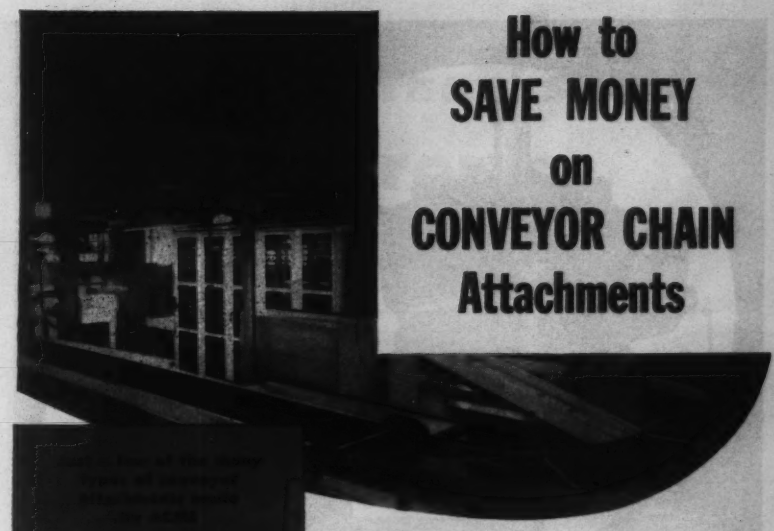
A specifications manual on double pipe or hairpin heat exchangers has been published by Brown Fintube Co.

Specifications Manual M-100 shows how to simplify heat exchanger specifications by using a single modular hairpin unit for all duties. The firm claims that, combined in proper series, parallel or series-parallel combinations, as the duty demands, the system by using one standard unit eliminates the delay and expense of designing different heat exchangers for each duty. —K-80

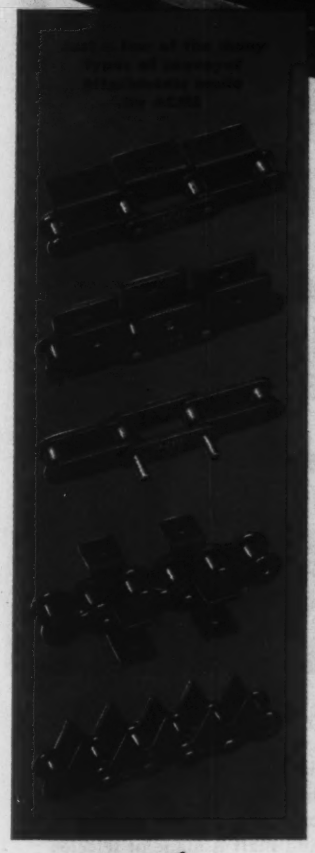
### Socket Screw Products

Bristol Co. has released a 32-page catalog of its socket screw products which includes new specification and design standards.

The catalog includes hex socket set screws, hex socket cap screws, hex socket flat head cap screws, hex socket button head cap screws, hex socket shoulder screws, and hex socket pipe plugs. Also included are multiple-spline socket set screws and cap screws, hex and spline keys and dowel pins. —K-81

How to SAVE MONEY on CONVEYOR CHAIN Attachments



By specifying Acme Standard Attachments wherever possible, a considerable saving in time and money can be made.

These low cost attachments are made to meet most ordinary requirements. They can be furnished individually, separate from the chain or they can be assembled into the chain either in riveted or detachable type.

SPECIAL CONVEYOR ATTACHMENTS

Possibilities for modification of Acme Standard Chains and Attachments are practically endless. In all adaptations, Acme engineers are skilled in retaining as many standard parts as possible to reduce cost, or design special attachments for your particular requirements. All Acme conveyor attachments and chains are available in standard, stainless steel or plated.

Write or call your local Industrial Distributors or our engineering department for time and money saving suggestions.

*Write Dept. 11-W for new 100-page illustrated catalog, including new engineering section showing 36 methods of chain adjustments.*

Call ACME for Service

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

Perfection Worm Gear Speed Reducers by American Stock Gear are available in 9 complete series with ratios ranging from 5 to 1 to 60 to 1 for input revolutions ranging from 300 per minute to 1800 per minute. Speed Reducers are furnished in horizontal right angle drive with worm in either top or bottom position and are also furnished in vertical right angle drive. Integral worm and shaft is made of selected quality, case hardened alloy steel. Threads are precision ground and accurately mated with worm gear. Shafts are mounted in Timken anti-friction roller bearings. Heavy rigid cast-iron housings . . . easily accessible oil filling level and drain plugs are provided for oil reservoir. Oil seals are of selected cirvis leather which assures maximum sealing effect. Available through your nearest American Stock Gear Distributor.

**Write for new 16 page catalog covering the complete PERFECTION Speed Reducer line.**

**AMERICAN STOCK GEAR DIVISION**
**PERFECTION GEAR COMPANY • HARVEY, ILLINOIS, U.S.A.**

# KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

## Shock, Noise Control

A 12-page bulletin describing Lord Mfg. Company's space-age capabilities in the field of engineered systems for shock, noise, and vibration control is now available.

Examples of standard, special, and high-performance mounting systems in the latest missiles and advanced jets are explained in full and illustrated. Typical equipment protected by the firm's systems and typical vehicle projects are listed. **—K–82**

## Pneumatic Transmitter

B-I-F Industries, Inc. announces a bulletin describing its BalanCel, a pneumatic transmitter which produces a change in output pressure proportional to a change in differential loading pressure within 1/2 of 1 per cent of full scale range.

The Model AT-SD is specifically designed for the water, sewage, and industrial fields for accurately transmitting rate of flow, loss of head, liquid level measurements, over distances to operate meters, valves, controls.

Operating on the force-balance principle, the transmitter is said to feature corrosion-resistant construction, high sensitivity, rapid response, no zero drift. **—K–83**

## Sight Flow Indicator

Jerguson Gage & Valve Co. has issued a bulletin covering sight flow indicators and drip sight feeder.

The new catalog, Data Unit No. 350 provides information on the range of sizes, materials, pressure-temperature ratings and dimensional specifications on reflex and transparent sight flow indicators which can be installed on new or existing pipe lines. Specifications on new high pressure drip sight feeder for low or high temperature applications are also included. **—K–84**

## Pressure Regulators

A catalog sheet available from Atlas Valve Co., describes two new differential pressure regulators for steam service.

These are the Fig. 1200, Type C, for controlling atomizing steam pressure at an adjusted value higher than fuel oil pressure and Fig. 1210, Type C, for controlling atomizing steam pressure at an adjusted value lower than fuel oil pressure. Range of pressure adjustment is 5 to 45 psi. **—K–85**

## Syncro-Matic Separator

A two page illustrated bulletin describing the firm's Syncro-Matic separator with TDM control has been issued by De Laval Separator Co.

The unit is a vibrating screen separator with controlled three dimensional motion—horizontal, vertical, and gyratory. The two-color bulletin features pictures of the machine, specifications, and blueprint diagrams. **—K–86**

## KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

### Power Piping

The story from material selection to erection of the 316 stainless steel power piping for the most severe temperature-pressure conditions of any existing utility (1200 F and 5000 psi) is told in a brochure published by M. W. Kellogg Co., Subsidiary of Pullman, Inc.

It describes the piping project for the Philadelphia Electric Co.'s new 325,000 Eddystone Plant No. 1 on the Delaware River. The 12-page brochure gives details of the services the firm performed. —K–87

### Heavy-Duty Compressors

An 8-page bulletin covering its 3-AT compressors is announced by Pennsylvania Pump & Compressor Co.

The bulletin, No. 350, describes the compressor as a horizontal, water-cooled, single-stage, heavy duty compressor, designed for use in approximately nine out of ten compressed air applications. Photographs, line drawings, and cross-sectional views illustrate construction, showing details of component parts. Sizes, capacities, and ratings are listed in tabular form. —K–88

### Variable-Speed Pulleys

Bulletin No. 4101, issued by T. B. Wood's Sons Co., describes a line of variable-speed pulleys designed to eliminate freezing and sticking.

The 12-page bulletin gives technical data for five MS sheaves designed for ratings of 2, 3, 5, 10, and 15 hp. The new pulleys have no keys to obstruct the flow of oil around the surfaces between the flange hub and sleeve. Power is transmitted from the stationary flange through a removable sleeve cap, which is keyed to the moving flange by torsionally resilient rubber keys. —K–89

### Steam Specialties

Steam specialties manufactured by Illinois Engrg. Div., American Air Filter Co., are described in a composite product bulletin.

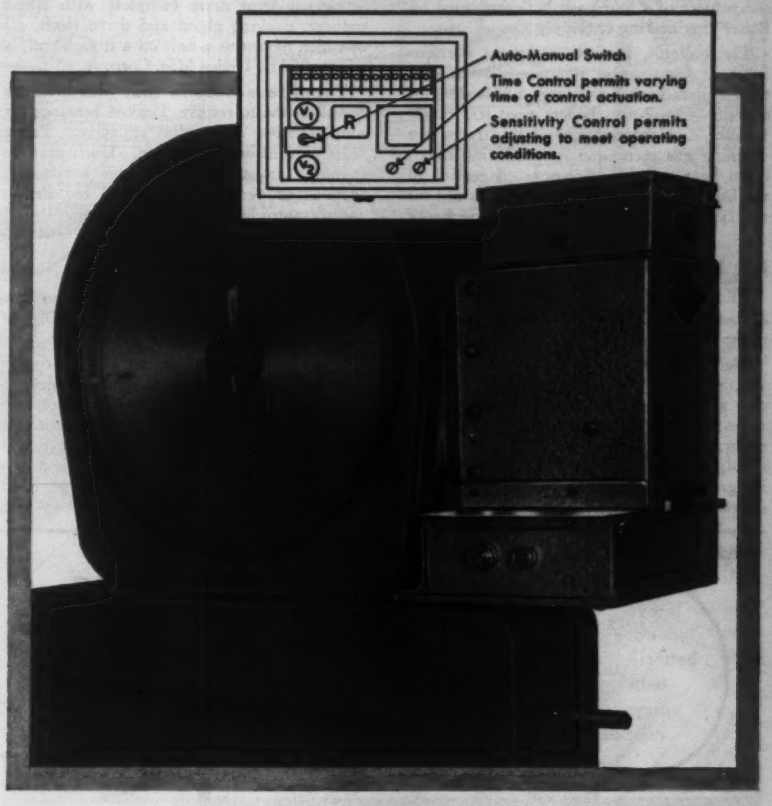
The 12-page bulletin discusses and illustrates valves, thermostatic traps, float and thermostatic traps, steam traps (250 psig maximum pressure as well as blast and high pressure) and pipe line strainers. Dimensions, capacities, patterns, weights, and accessories are included. —K–90

### Pressure Plugs

Pressure plugs which seat flush—said to be the first such plugs to be offered commercially—are described in a bulletin by Standard Pressed Steel Co.

They are called Levl-Seal, and are designed for flush-seating to within half a pitch in hydraulic, pneumatic, or other high-pressure systems. The company says conventional pressure plugs have a full pitch tolerance and usually protrude by four full turns. —K–91


# NEW Fairbanks-Morse Electronic Weight Detector


Auto-Manual Switch
Time Control permits varying time of control actuation.
Sensitivity Control permits adjusting to meet operating conditions.

**Prevents incorrect weighing . . . stops costly errors!**

With the new Electronic Weight Detector, true weight of any load can be automatically obtained and recorded without need of a weighman. Where a weighman is used, it is impossible for him to record incorrect weights or start a sequence at the wrong time. When desired, a flip of the switch can disengage the Weight Detector entirely from the system. *This is the first fully-reliable control of its kind available in the scale industry.*

To completely automate your weighing—to be sure that your weights are correct—to protect yourself by completely policing your entire weighing operation—contact your nearby Fairbanks-Morse Field Engineer, or write directly to Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Illinois for complete information.

**See Sweet's Plant Engineering File for full line of F-M Scales**

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GENERATORS • COMPRESSORS • MAGNETOS • HOME WATER SYSTEMS

# KEEP INFORMED

## NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

### Two-Pass Boilers

Two-pass firetube packaged boilers are the subject of a four-page bulletin issued by Boiler Engineering & Supply Co.

The bulletin, BE-100, compares the features of Continental two-pass oil- or gas-fired boilers with 3-pass and 4-pass designs, explains why 2-pass boilers need less maintenance and downtime, and illustrates the spinning gas technique for achieving maximum heat transfer efficiency. A section of the bulletin is devoted to an analysis of heat transfer in boiler tubes. —K-92

### Air, Vacuum Pumps

A 16-page catalog, No. 359, describes Leiman Bros. rotary positive air and vacuum pumps, gas boosters and air motors.

Details of construction, dimensions, capacities, new performance curves, installations are given. Included are 2- and 4-vane types; fan-cooled, water-cooled and new radiator air-cooled models; motor driven units; direct-coupled and belt-driven models; integral pump and motor; automatically controlled tank units. —K-93

### Screw Conveyor Drives

A 16-page bulletin describing a compact screw conveyor drive complete with speed reducer, packing gland and drive shaft, all of which mount as a unit on a trough end, is announced by Dodge Mfg. Corp.

The drive is precision built with housings bored in line to receive Timken bearings for ample thrust and radial capacity. Triple seals prevent contamination. Units may be mounted in any position, on horizontal, inclined or vertical shafts, and require no sliding motor base for belt tensioning. —K-94

### Air Motors

Bulletin 215 describes the air motor line recently introduced by Hannifin Co., Div. of Parker-Hannifin Corp.

The eight page, illustrated bulletin covers features, specifications, and dimensions for the five bore sizes available in each of four mounting styles. A section showing accessories and an explanation of how the motor works is also included. The motor is a new combination cylinder and solenoid actuated air control valve. —K-95

### Silicon Carbide

A technical data sheet on silicon carbide-bonded graphite, listing the description, properties, erosion test results, and fabricability of the new product is available from Research and Development Div., Carborundum Co. —K-96

### Automatic Control Panels

Clark Bros. Co. has issued an illustrated bulletin, No. 170, presenting its packaged automatic control panels for gas-engine driven compressors.

Three basic control panels are described: Model SE, sequenced engine control, which enables operator to start or stop engine with push of a single button; Model SEC, a fully automatic engine and compressor control which monitors and controls automatically all phases of engine, compressor and yard valve operation from start to stop; and Model SEC-R, a fully automatic control for remote location, suitable for tie-in with computers at central dispatch office to program, monitor, and automatically control an entire pipeline system. —K-97


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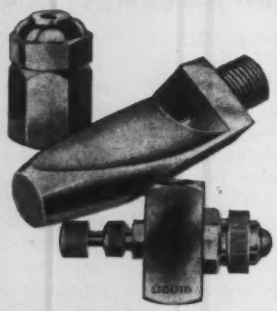

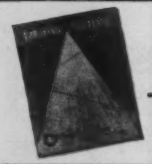

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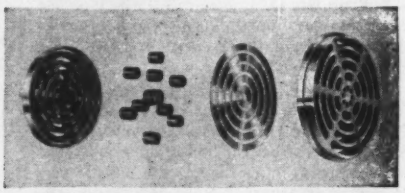

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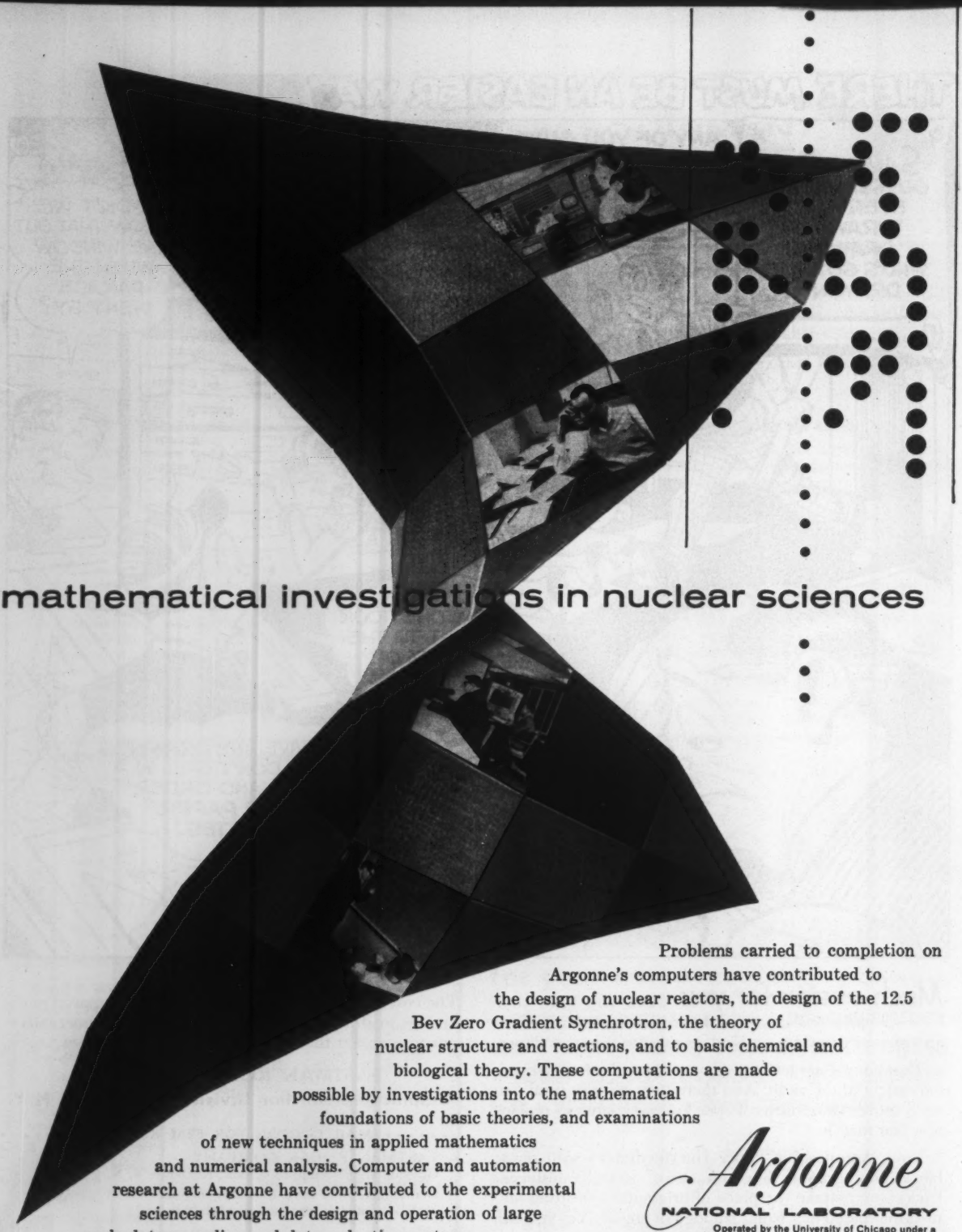

# mathematical investigations in nuclear sciences

Problems carried to completion on Argonne's computers have contributed to the design of nuclear reactors, the design of the 12.5 Bev Zero Gradient Synchrotron, the theory of nuclear structure and reactions, and to basic chemical and biological theory. These computations are made possible by investigations into the mathematical foundations of basic theories, and examinations of new techniques in applied mathematics and numerical analysis. Computer and automation research at Argonne have contributed to the experimental sciences through the design and operation of large scale data recording and data reduction systems.

In order to serve the mathematical needs of its scientists and engineers, Argonne operates an analogue computer, PACE; an IBM 704; and GEORGE, a digital computer designed and constructed at the Laboratory.

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Bailey Controls for combustion, feed water and steam temperature at the Bay Shore Station of the Toledo Edison Company. The FPC reported a 1957 heat rate at Bay Shore of 9,210 Btu per kwhr, making it one of the 15 most efficient plants in the United States.

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Year after year you'll find Bailey Meters and Controls keeping sensitive fingers on the pulse of America's *most efficient* power plants (as rated by the Federal Power Commission.

According to the latest box scores, 10 of the top 15 used Bailey equipment exclusively. There must be a reason. There is! In fact, several:

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**2. Complete Line**—Bailey manufactures a complete line of pneumatic and electric metering and control equipment, proved on thousands of successful installations.

**3. Sales and Service**—There's a Bailey District Office or Resident Engineer close to you (listed under Bailey Meter Co. in your phone book). Phone for expert engineering counsel.

* 15 MOST EFFICIENT PLANTS • 1957 Heat Rates Reported by the Federal Power Commission

| | Btu/kwhr | Meters | Comb. Control | Feed Water Control | Supht. Control |
|---|---|---|---|---|---|
| 1. Kanawha River (Appalachian Electric Power Co.) | 9,118 | B | B | B | B |
| 2. Muskingum River (The Ohio Power Co.) | 9,139 | B | B | B | B |
| 3. River Rouge (The Detroit Edison Co.) | 9,140 | — | — | — | — |
| 4. Clifty Creek (Indiana-Kentucky Electric Co.) | 9,147 | B | B | B | B |
| 5. Tanners Creek (Indiana and Michigan Electric Co.) | 9,180 | B | B | B | B |
| 6. Kyger Creek (The Ohio Valley Electric Corp.) | 9,201 | B | — | B | B |
| 7. St. Clair (The Detroit Edison Co.) | 9,210 | B | B | B | B |
| 8. Bay Shore (The Toledo Edison Co.) | 9,210 | B | B | B | B |
| 9. G. G. Allen (Duke Power Co.) | 9,349 | B | B | B | B |
| 10. John Sevier (Tennessee Valley Authority) | 9,350 | — | — | — | — |
| 11. Phillip Sporn (Central Operating Co.) | 9,370 | B | B | B | B |
| 12. Milliken (New York State Electric and Gas Co.) | 9,371 | B | — | B | — |
| 13. Shawville (Pennsylvania Electric Co.) | 9,396 | B | — | — | B |
| 14. El Segundo (Southern California Edison Co.) | 9,467 | B | B | B | B |
| 15. Colbert (Tennessee Valley Authority) | 9,490 | B | B | B | B |

A141-1

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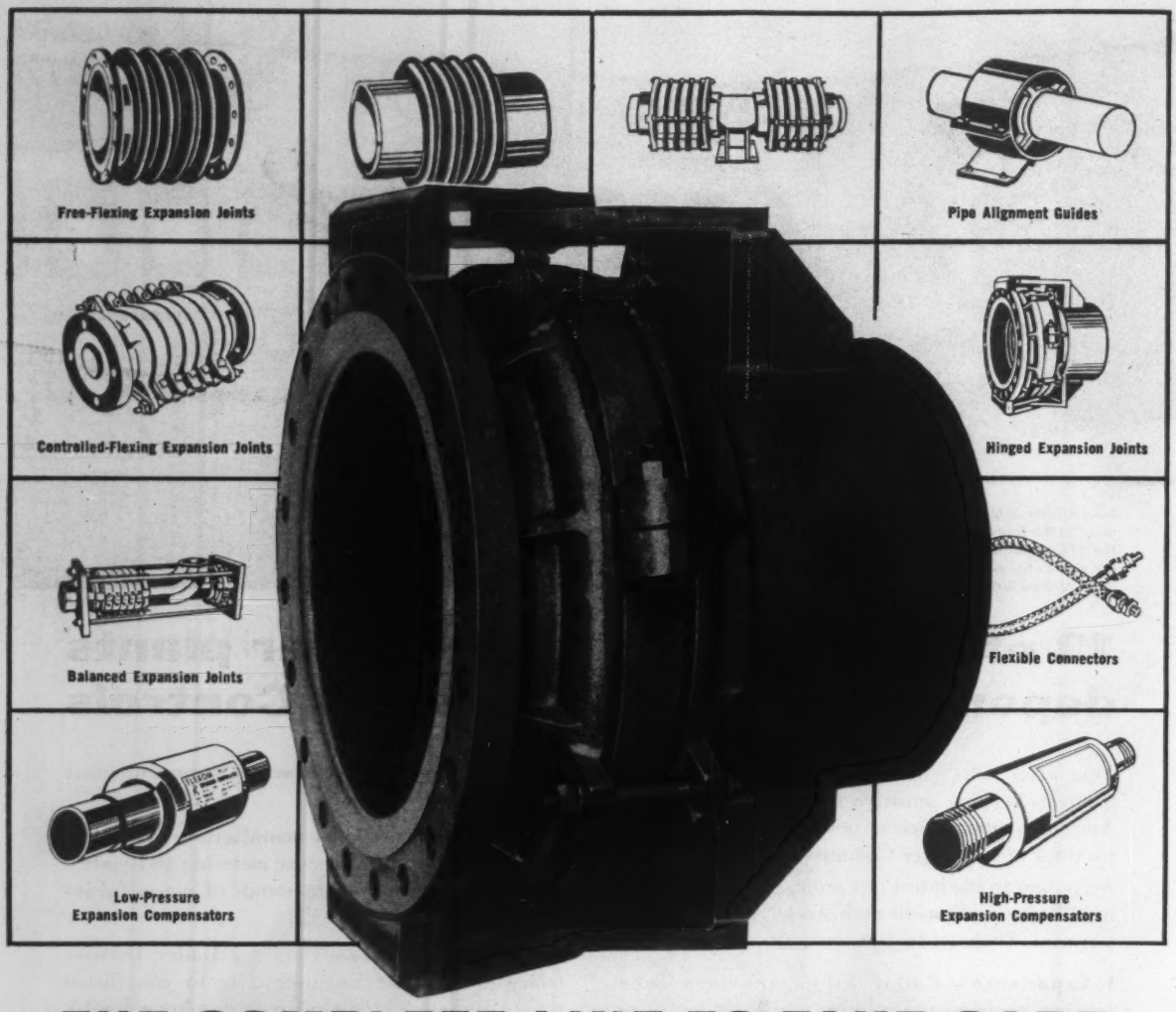


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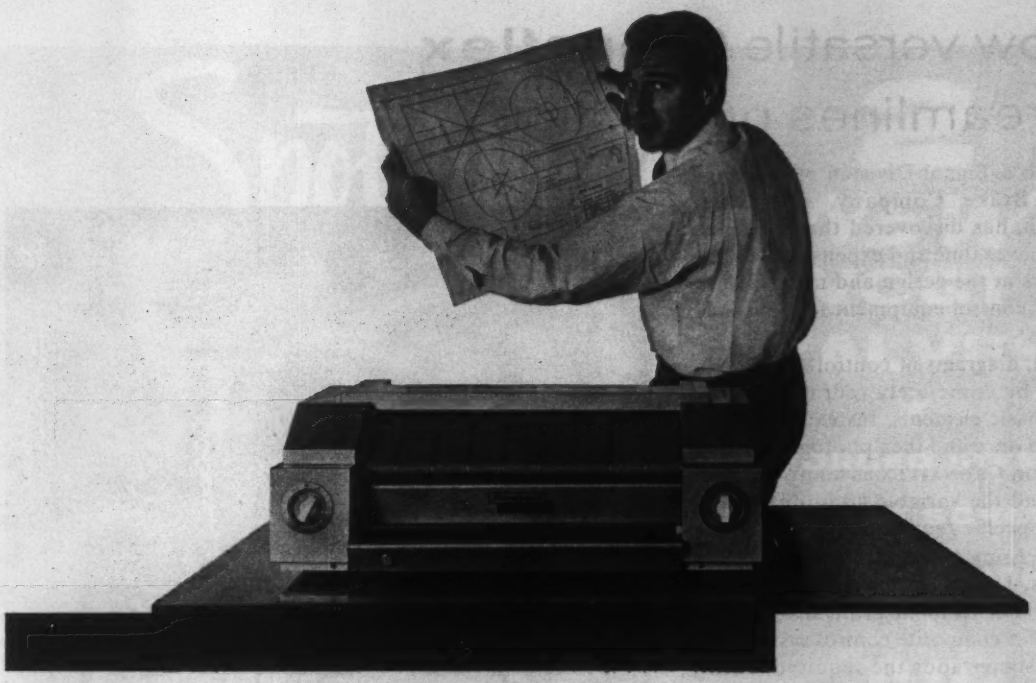

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# How versatile **Cronaflex** Trademark streamlines production

Union Switch & Signal Division of Westinghouse Air Brake Company, Swissvale, Pennsylvania, has discovered that Du Pont CRONAFLEX saves time and expense in several different ways in the design and manufacture of automatic control equipment for railroads and pipelines.

First of all, diagrams of control systems do not have to be completely redrawn if they contain the basic elements. Instead, the basic data is drawn once and then photographically reproduced on CRONAFLEX as many times as necessary, and the variable additions added to meet the specific requirement.

When preparing wiring diagrams for complex systems, Union Switch & Signal starts with reproducible template prints that contain basic parts of a composite control system. On these the designer adds the required wiring information. Then he cuts out the unused elements and reproduces the selectively cut print on CRONAFLEX, which serves as the final tracing.

CRONAFLEX is also used to make accurate, legible reproduced tracings of valuable originals which due to age and use have developed poor contrast causing illegible reproductions.

In addition, CRONAFLEX helps this company put an accurate picture directly on metal or plastic parts, eliminating expensive layout time for machining operations. The material is spray-coated with a photosensitive emulsion, placed in contact with the layout drawing on CRONAFLEX, and exposed in a vacuum frame. After development the piece is engraved, punched or machined for use as part of a product or used as a template in punching operations, directly from the picture on the material. This is feasible because CRONAR* base of CRONAFLEX resists shrinking and stretching caused by changes in temperature and humidity.

Versatile CRONAFLEX can work profitably for you, too. For more information write E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, Wilmington *98*, Delaware. In Canada: Du Pont of Canada Limited, Toronto.

Unwanted elements of a drawing are cut from the composite print before reproducing on CRONAFLEX. This saves time spent in laborious eradicating.

CRONAFLEX is also used to make metal or plastic templates. Material is spray-coated with emulsion, then CRONAFLEX drawing is printed right on the surface.

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# Who Discovers the Discoverers?

*"A professor can never better distinguish himself in his work than by encouraging a clever pupil, for the true discoverers are among them, as comets amongst the stars."* CARL LINNAEUS

Somewhere in this mighty land of ours, a gifted youth is learning to see the light of tomorrow. Somewhere, in a college classroom or laboratory, a dedicated teacher is gently leading genius toward goals of lofty attainment. Somewhere the mind of a future discoverer—in science, engineering, government, or the arts—is being trained to transcend the commonplace.

Our nation has been richly rewarded by the quality of thought nurtured in our colleges and universities. The caliber of learning generated there has been responsible in no small part for our American way of life. To our college teachers, the selfless men and women who inspire our priceless human resources, we owe more than we will ever be able to repay.

*Yet how are we actually treating these dedicated people?* Today low salaries are not only driving gifted teachers into other fields, but are steadily reducing the number of qualified people who choose college teaching as a career. At the same time, classrooms are beginning to get overcrowded. In the face of this, college applications are expected to double by 1967.

This is a severe threat to our system of education, to our way of life, even to our very existence as a nation. Our colleges need help—and they need it now!

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*Raytheon Trademark

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Engineering Laboratories: *Wayland, Maynard, Sudbury, Mass.; Santa Barbara, Calif.*
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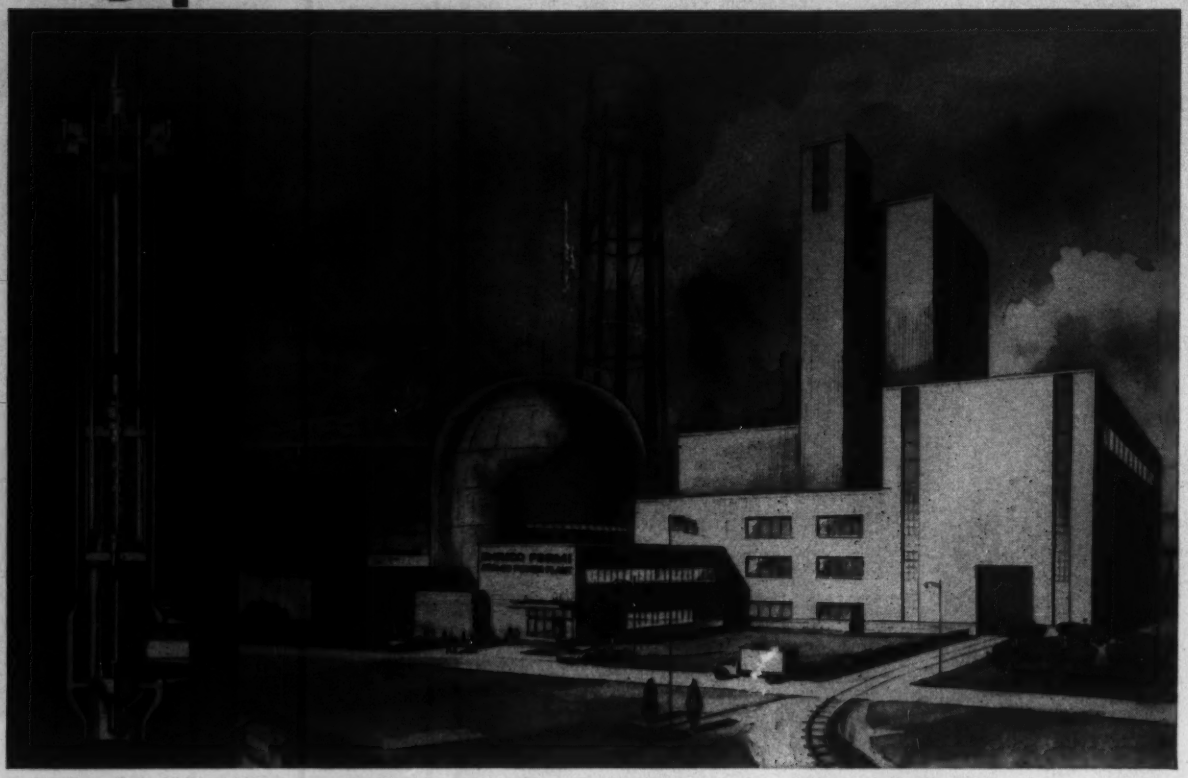
GOVERNMENT EQUIPMENT DIVISION

LAND SEA AEROSPACE

*How Copes-Vulcan control systems boost power plant efficiency*



**Valves are "canned"** with the inner assembly placed in a sealed container from which it can be removed by an automatic manipulator without draining the system.

**The plant,** under construction at Lagoona Beach, Michigan, represents a joint effort of some 50 companies. Reactor design rating: 300 megawatts of heat, 100 megawatts electrical power.

# Copes-Vulcan nuclear valves at Enrico Fermi Atomic Power Plant

This liquid sodium valve is one of three Copes-Vulcan has furnished to serve as throttling devices in the blanket feed lines at the Enrico Fermi plant.

In leak tightness of stem, resistance to corrosion, full-safe operation, and remote maintenance, these valves meet the rigid requirements demanded by primary-fluid nuclear service.

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**Nuclear valves for submarines, carriers, atomic plants, and test reactors.** For all these advanced projects, Copes-Vulcan is building valves. Here's real proof of the acceptance of Copes-Vulcan's skill and integrity in a field where precision is a critical requirement.

*You are invited to inspect Copes-Vulcan facilities.*

**Copes-Vulcan's extensive hydrostatic testing facilities** include a hot test loop (shown above) that will pass up to 50-gpm at 2500 psig and 600°F. Two cold test loops have 200-gpm and 800-gpm capacities.

## Copes-Vulcan Division
### BLAW-KNOX COMPANY
**Erie 4, Pennsylvania**

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Curtis packaged units minimize floor area, require factory assembly and tested, field installation requires only setting and connecting utilities.

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OUR 105th YEAR

WRITE DEPT. 8, ST. LOUIS 20, MISSOURI

THE CURTIS "LUXURY LINE" OF AIR CONDITIONERS COSTS NO MORE

# Expansion Joint Design Moves out of the "Model T" Era

**Badger first began fabricating packless metal bellows expansion joints more than 35 years ago. These "Model T" joints performed (and are still performing) with outstanding success in hundreds of process and steam line piping installations.**

**Starting in the 30's other expansion joint manufacturers entered the field. The most successful adopted many of the basic features of the original Badger design.**

**During the last decade, as industry's requirements became more stringent, and joint manufacturers gained fabricating and field experience, certain fundamental problems inherent in the early designs became evident. Most of these problems were solved through a series of modifications. (Among which was the Badger Directed Flexing Self-Equalizing Joint — the famous "DFSE" Design.) But, at best, the modifications were stop-gap measures which complicated the joints and greatly increased their weight. A fundamental reassessment of expansion joint engineering data was needed. Badger led the way: In 1956, a task force completed a three-year research program and the first S-R (Service-Rated) Expansion Joints were produced.**

**In the three years they have been available, S-R Expansion Joints have been both an engineering and a sales success. But like many revolutionary concepts which upset tradition, the full implication of the advantages S-R Joints offer is still not universally understood. The message that follows is an attempt "to set the record straight."**

• • • • •

## Equalization — fact and fiction

Many users of expansion joints are under the impression that the so-called "equalizing" rings on today's conventional type expansion joints distribute movement equally among all the corrugations of the bellows. It is argued that as the joint absorbs thermal movement, the tops of the rings progressively come into contact until the bellows is fully compressed thus limiting the amount of compression which any one corrugation can ultimately absorb (see diagram 1). In *this* sense the rings do contribute to the "equalization" of movement by physically limiting the compression of each corrugation to the distance between any two adjacent rings.

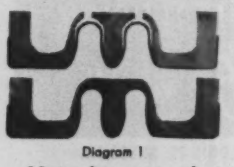

Diagram 1

**Conventional Type Expansion Joint.** Cross-sections of rings and bellows of a conventional "self-equalizing" joint showing cold and hot positions. Note that true equalization of movement can only be obtained when tops of all rings are in contact — an impractical and dangerous situation.

Note, however, that the degree of compression will not be truly equalized until the tops of all the rings are in contact. But, when such a condition occurs, serious problems will result. If the limit of compressibility is reached before the thermal expansion has been completely absorbed, exceedingly large forces will be transmitted through the pipe line to the anchors and connected equipment. On the other hand, if the joint is compressed only partially, not all of the corrugations will absorb movement to the same degree.

## How S-R Joints solve equalization problem

Badger S-R Expansion Joints feature the new Curvilinear Corrugations which naturally assume an "all curve" shape under pressure (diagram 2), assuring more equal distribution of stresses throughout the bellows material. Furthermore, the shape, height and pitch of the corrugations are based on a carefully engineered correlation. Thus, reasonably equal distribution of movement among the corrugations is obtained, even in joints not equipped with reinforcing rings.

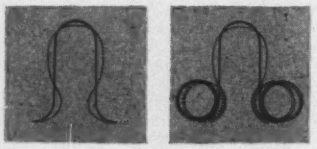

Diagram 2

**Badger S-R Expansion Joint.** Cross-sections of S-R Joints (Series 50 left, Series 150 right). The movement of the corrugations is shown by dotted and solid lines. Compare configuration and effective height of corrugations, position and size of rings with conventional joint.

Equalization of movement is inherent in the design and functioning of the bellows on Badger S-R Joints. On the basis of provable engineering criteria, the prime purpose of reinforcing rings of any design is to retain the hoop dimension (diameter) of the corrugations when they are subject to internal pressure. This Badger's simple, lightweight tubular reinforcing rings do. But, in addition, the new tubular shape of the rings does contribute to joint flexibility and life by permitting flexing over a more effective portion of the total corrugation height than conventional cast or fabricated equalizing rings.

## Better performance, lower cost

Briefly, then, Badger S-R Joints alone offer these advantages: Better equalization of movement which results in elimination of localized stresses and leads to longer joint life; a simple, lightweight design that makes installation easier, eliminates cumbersome castings and fragile mechanical devices; complete range of sizes from 3" to 72" made from any workable metal and with a wide choice of accessories.

Badger S-R Joints are probably the answer to your problem. There's an easy and quick way to find out — ask the Badgerman for his recommendations. Write or phone today. Badger Manufacturing Co., 230 Bent St., Cambridge, Mass.

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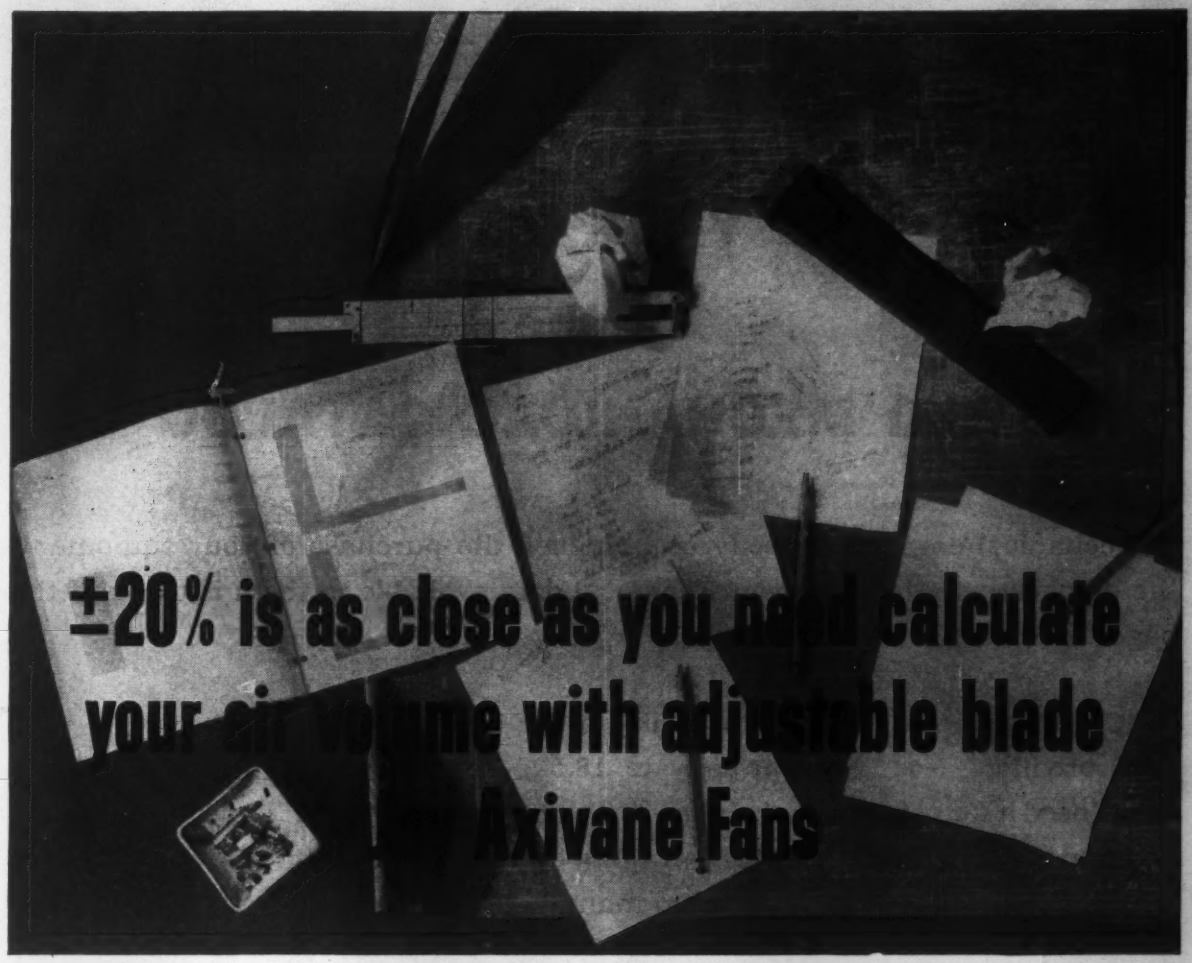
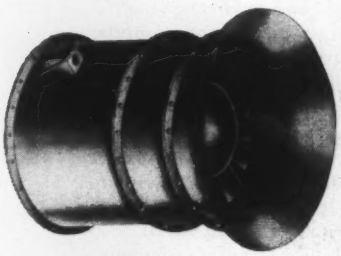
**BADGER S·R EXPANSION JOINTS**



*Ask for Bulletin 290-80B.*

Computation of air volumes required for ventilation can be greatly simplified by installing Joy Axivane Fans. Standard models are furnished with adjustable blades which can be rotated to change pitch, and consequently volume, over a considerable range. This permits compensating for circumstances unforeseen when air requirements were computed, and also allows the installation of fans which will be able to efficiently supply additional air for pre-planned expansions of the plant. Blade adjustments can be made by anyone in a matter of minutes. Calibrated scales on hub and blades assure accurate matching of blade pitches.

Joy Axivane Fans are designed with integral motors to permit in-duct installation. This reduces installation costs, and saves space. The fans are available in a wide range of sizes for every type of duty, and can be furnished in special materials for use in corrosive atmospheres.

Whatever your fan requirements may be, Joy has the answer.

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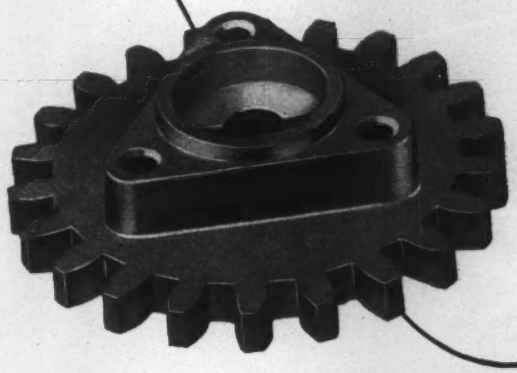
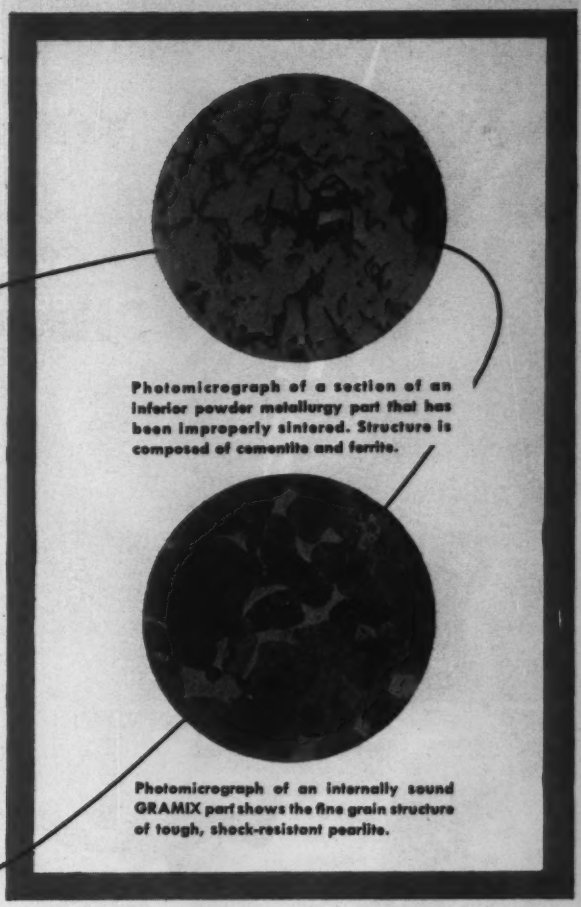
# Quality of GRAMIX® precision parts insured by metallurgical control in the laboratory *proven by performance on the job!*



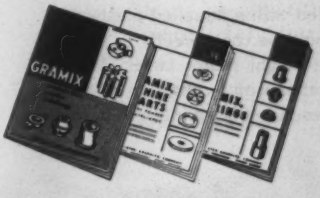


Photomicrograph of a section of an inferior powder metallurgy part that has been improperly sintered. Structure is composed of cementite and ferrite.

Photomicrograph of an internally sound GRAMIX part shows the fine grain structure of tough, shock-resistant pearlite.

To assure the dependable performance of GRAMIX powder metallurgy parts in actual operation, the United States Graphite Company combines exacting laboratory tests and rigid production controls to insure the quality of every GRAMIX part. Through the use of the metallograph, for example, GRAMIX engineers can check the internal structure of a part. A comparison of the photomicrographs shown above readily shows the sound under-the-surface quality of a GRAMIX part as opposed to the poor internal composition of an improperly sintered part. In the photomicrograph at the top, notice the cementite between the ferrite grain boundaries. This cementite will tend to break up and rupture under shock. The surface of the material is decarburized and only remnants of pearlite remain. *This condition is due entirely to the lack of adequate sintering control!*

The photomicrograph of the GRAMIX part at the bottom shows a fine grain pearlite structure that's tough, strong and wear resisting. Absolute sintering control along with precise metallurgical control in the laboratory is utilized by The United States Graphite Company to positively assure quality GRAMIX parts.




Write today for these helpful engineering manuals. Engineering Bulletin No. 18 covers design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 contains facts about GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy. Get your copies now.

X-264-1R

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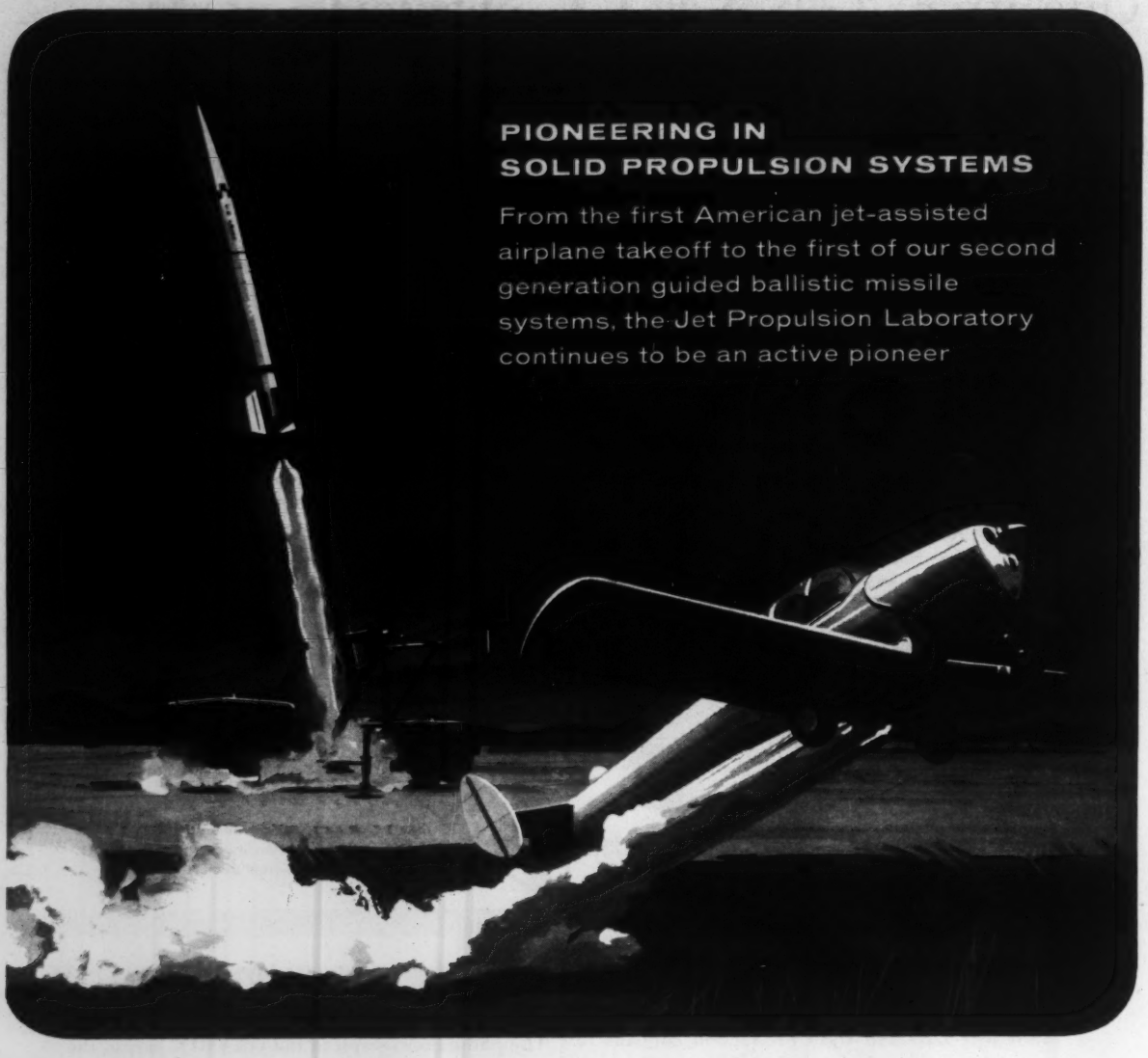
## NOTABLE ACHIEVEMENTS AT JPL...


PIONEERING IN
SOLID PROPULSION SYSTEMS
From the first American jet-assisted airplane takeoff to the first of our second generation guided ballistic missile systems, the Jet Propulsion Laboratory continues to be an active pioneer

In August 1941, America's first jet-assisted airplane takeoff was accomplished with an Ercoupe monoplane, using JPL developed solid propellant rockets. Scientists at JPL shortly discovered that a powdered perchlorate oxidizer, mixed with a liquefied plastic fuel binder, could be cast directly in plastic-lined light-weight motor cases. Thus a safe and cheap method was now available for preparing large internal-burning composite propellant charges. This basic process became the foundation for the modern solid propellant industry.

In 1954, U. S. Army Ordnance requested JPL to develop a compact, rugged long-range guided missile weapon system that could be transported, aimed and fired as simply as a cannon. Within five years, JPL perfected the **Sergeant,** the first of America's second-generation guided ballistic missiles. In January 1958, clusters of small-scale **Sergeants** helped launch America's first earth satellite, the JPL built **Explorer,** which provided vital space environment information.

Now under the direction of the National Aeronautics and Space Administration, the experienced JPL research and development team continues to apply solid propellant vehicles for space exploration.

jpl

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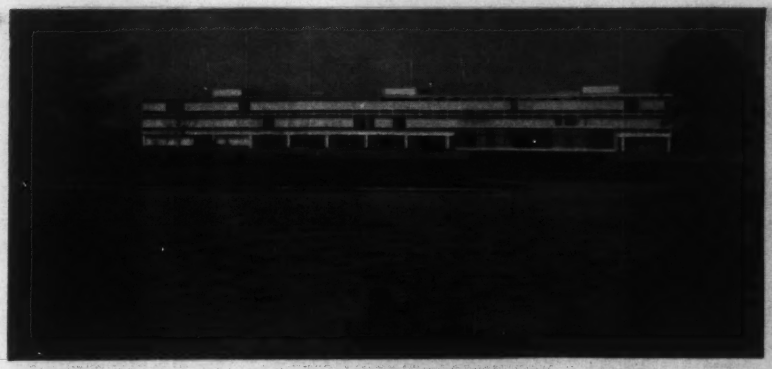
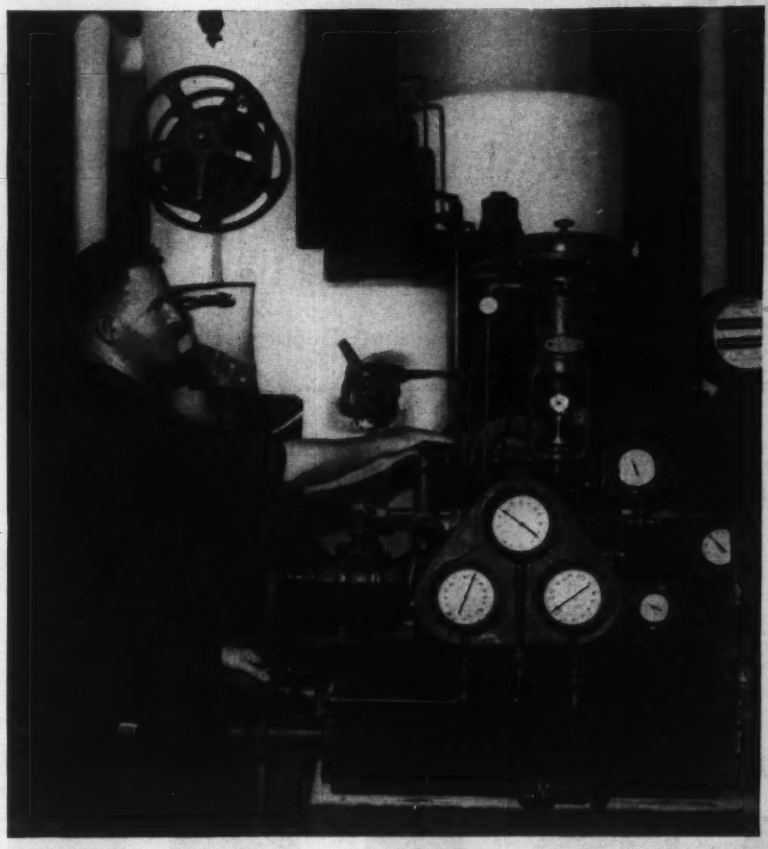


New home office for Connecticut General Life is a modern structure five miles out in the country.

# Terry turbines power air-conditioning system at new Connecticut General Life building



One of two 870-hp, 3970-rpm Terry turbines built to drive the refrigeration compressors.

The new home office of the Connecticut General Life Insurance Co., in suburban Hartford, represents the best in contemporary architecture as well as construction techniques and materials.

In keeping with the careful planning evident throughout the project, two Terry turbines were selected to drive the York centrifugal refrigeration compressors. Terry turbines such as these have a record of low maintenance and consistent reliability under varied conditions. The steam generators, which are used for general heating during the winter months, furnish the power to operate the turbines. This provides an economical and dependable air-conditioning setup.

The steel and glass building accommodating 2500 employees overlooks New England farmland. It is furnished with modern equipment, to step up the efficiency of clerical work. Other amenities: lounges, game rooms, cafeteria, bowling alleys, barber and beauty shops, variety store, medical department.

If you are planning an air-conditioning system, perhaps you, too, should consider steam-turbine drive. Write for detailed information about the advantages of turbines for your specific requirements.

**THE TERRY STEAM TURBINE CO.**
**TERRY SQUARE, HARTFORD 1, CONN.**

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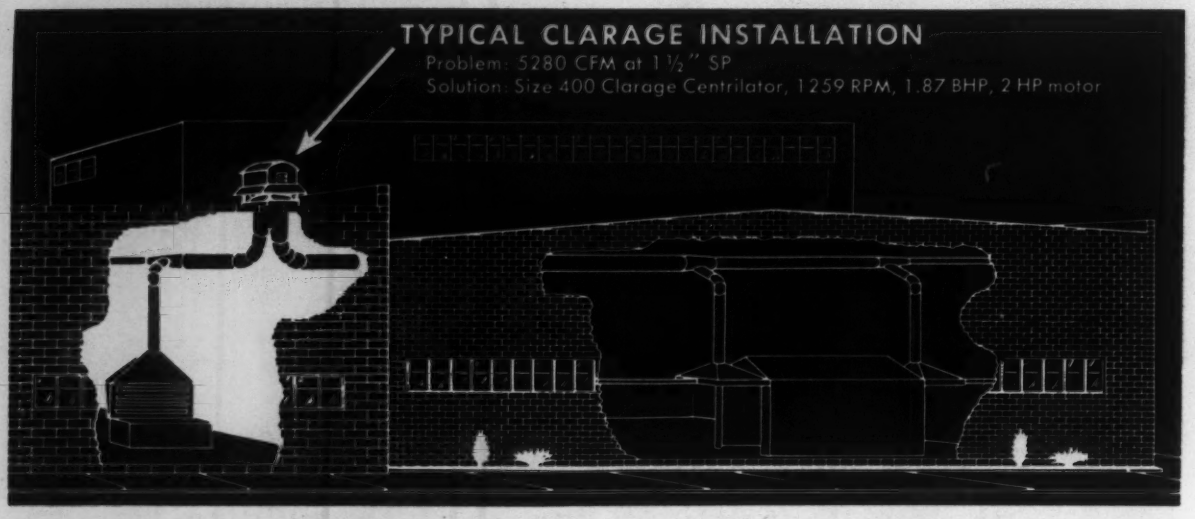
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Problem: 5280 CFM at 1½" SP
Solution: Size 400 Clarage Centrilator, 1259 RPM, 1.87 BHP, 2 HP motor

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V-belt driven centrifugal type with backwardly inclined blade wheel. 10 sizes. Capacities from 1,500 to 26,500 CFM. (Shown above with weather enclosure and two sides of air apron removed.)

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*Dependable equipment for making air your servant*

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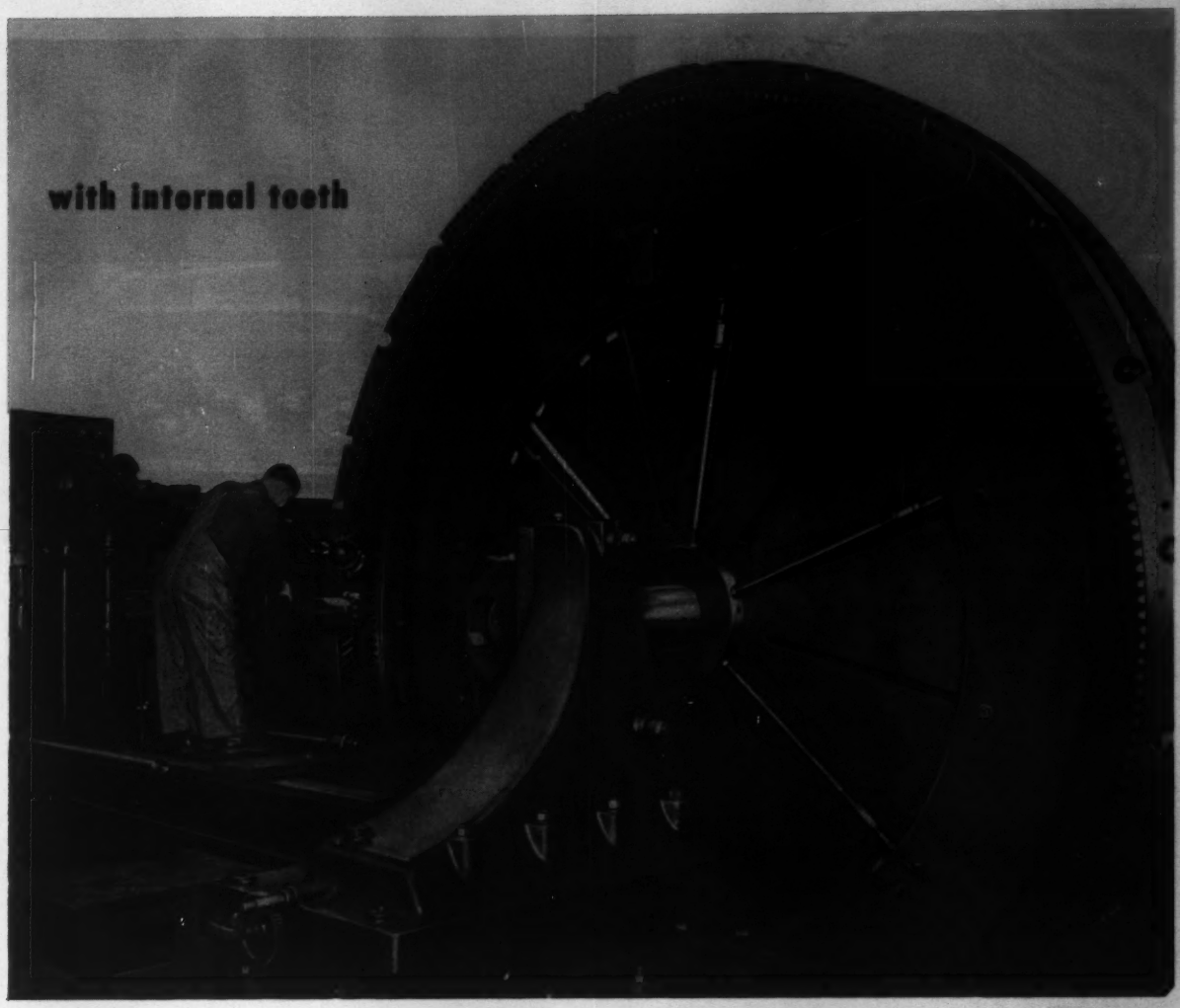
*Kalamazoo, Michigan*

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For 35 years the company's Buffalo plant has specialized in the production of large gears for various industrial uses. Here eight of the world's largest gear generators are kept in regular use. The precision inherent in the operating principle of these Farrel-Sykes machines provides accurate tooth spacing, profile and helix angle.

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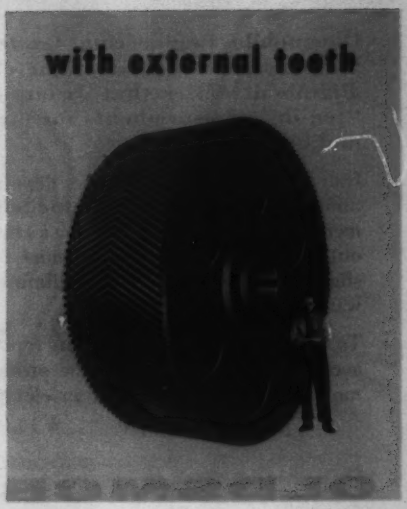
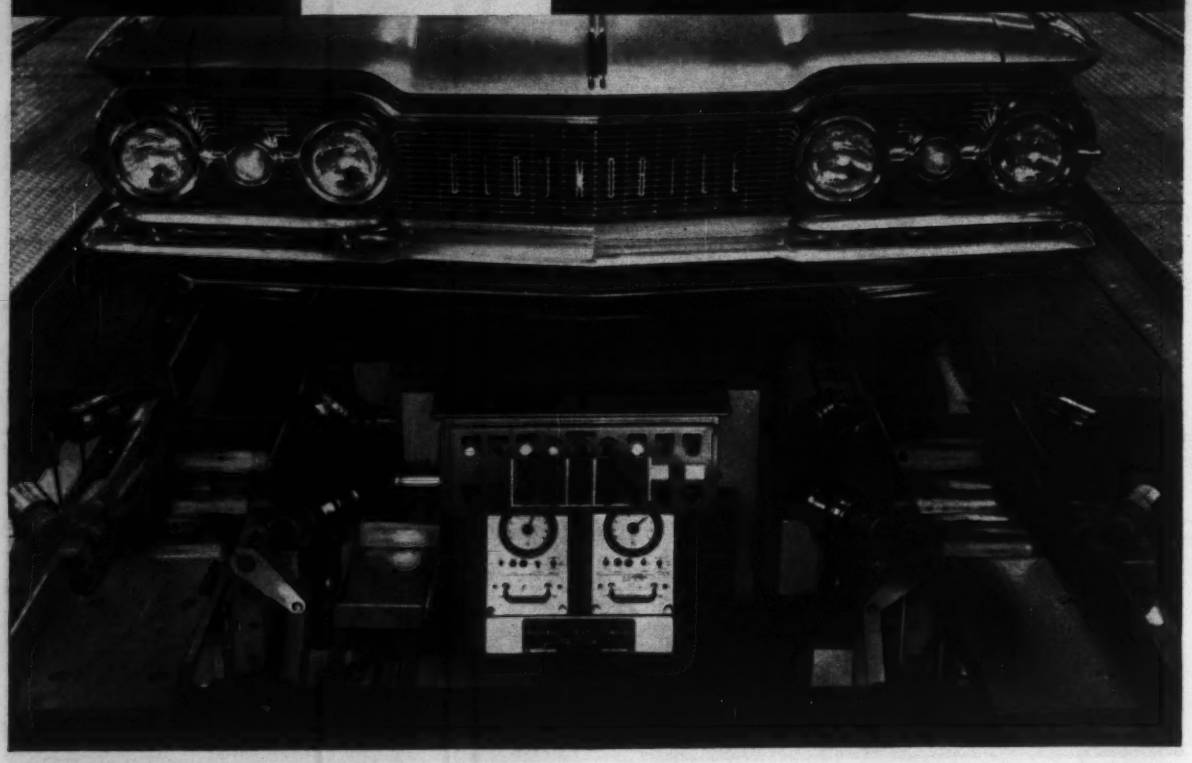



FB-1158

*The Inquiring Mind at Oldsmobile*



no. 9 OF A SERIES

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OLDSMOBILE DIVISION • GENERAL MOTORS CORPORATION

**OLDSMOBILE** **Where Proven Quality Is Standard!**

# Easy-To-Install, Reliable, Low-cost "BUFFALO" Belted Vent Set "Packages"

"Buffalo" Belted Vent Sets are uniquely flexible "packages" readily adaptable to a wide variety of ventilating and air conditioning jobs:

- **Smaller, Independent Systems**
- **Larger Systems with Variable Needs**
- **Separate Systems in Different Areas**
- **Indoor or Outdoor Installations**

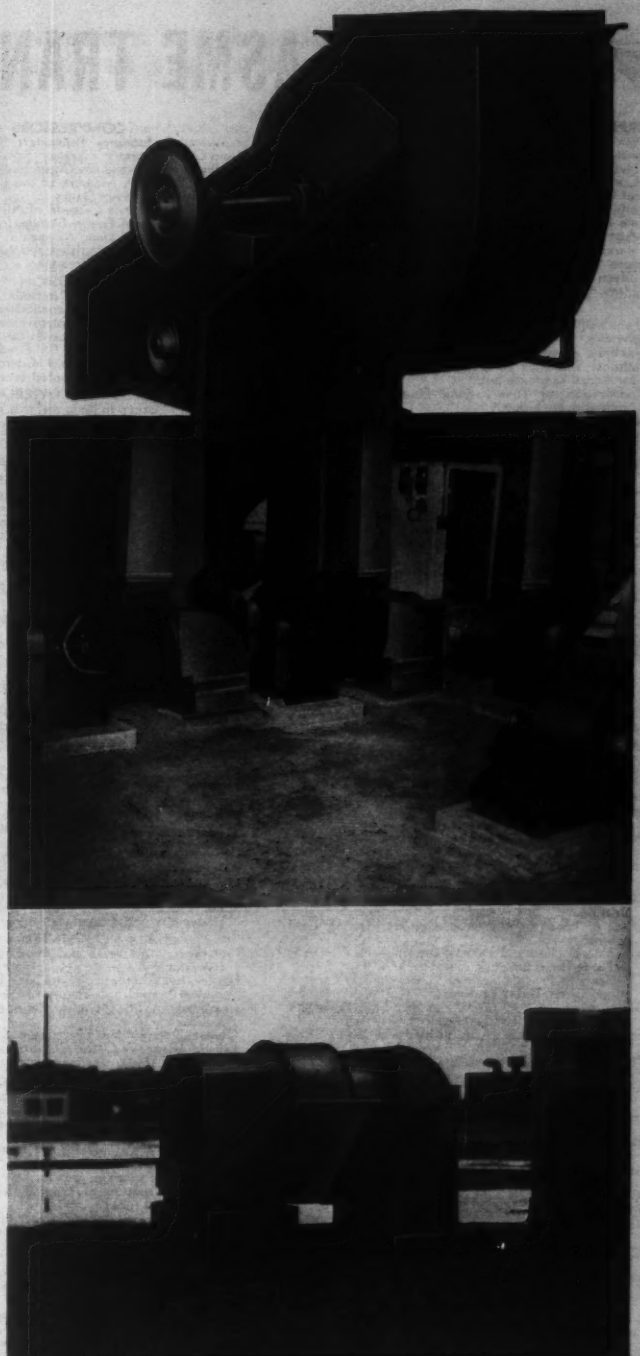
"Buffalo" Belted Vent Sets are easy-to-install because they are shipped as compact, self-contained, "ready-to-set-up-and-operate" packages. Each unit is complete with fan, motor and V-belt drive.

Service problems are minimized because these dependable units are ruggedly built throughout. Heavy-gauge steel housings, oversize shafts and bearings contribute to a long, useful life of maintenance-free operation. This adds up to far fewer service "headaches" for you.

Performance is outstandingly quiet, efficient, economical. This is the result of Buffalo's "big fan" features: smoothly-curved inlet vanes reduce turbulence—backward-curved blades give non-overloading characteristic — factory-balanced wheels minimize vibration.

Capacities range from 500 to 20,000 cfm. Adjustable pitch motor sheaves permit variable capacities for future needs. Can be supplied with special protective coatings or special materials for use as fume hood exhausters.

Investigate the many advantages of "Buffalo" Belted Vent Sets. Contact your nearby "Buffalo" engineering representative, or write for Bulletin 3720-A.



*Upper photo:* Multiple indoor installation of "Buffalo" Belted Vent Sets. *Lower photo:* "Buffalo" Belted Vent Sets are available with all-weather drive cover for roof or other outdoor installations.

"Buffalo"

**BUFFALO FORGE COMPANY**
**Buffalo, New York**
Buffalo Pumps Division, Buffalo, New York
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Transient Temperature and Thermal Stresses in Skin of Hypersonic Vehicle With Variable Boundary Conditions.
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Some Methods for the Structural Design of Wings for Application Either at Ambient or Elevated Temperatures.
Simple Method of Estimating the Reynolds Number Effects on Aircraft Gas-Turbine Engines Operating at High Altitudes.

### AUTOMATIC CONTROL

Analysis of the Transient Response of Nonlinear Control Systems.
Algebraic Approach to Design of Automatic Controls.
Statistical Treatment of Sampled-Data Control Systems for Actual Random Inputs.
Optimization of Time-Varying Linear Systems With Nonstationary Inputs.
Design of Self-Optimizing Control System.
Correlation Functions and Noise Patterns in Control Analysis.
Analog Study of a High-Speed Recording Servomechanism.
Survey of Mathematical Methods for Nonlinear Control Systems.
Development of the Generalized Phase-Diagram Method.
On-Off Control With Periodic Sensing Device.
Dynamic Characteristics of Cam Forms Calculated by the Digital Computer.
Subharmonic Oscillations of Nonlinear Feedback Control Systems.
Optimal Synthesis of Linear Sampling Control Systems Using Generalized Performance Indexes.
Time Domain Synthesis of Sampled-Data Control Systems.
Continuous Measurement of Characteristics of Systems With Random Inputs: A Step Toward Self-Optimizing Control.

### BEAMS—COLUMNS

Timoshenko Beams Under Dynamic Loads.
Natural Frequencies of Nonuniform Beams.
Large Deflection of Cantilever Beams.
Coupled Vibrations of Thin-Walled Beams.
Timoshenko Beam Equation for Short Pulse-Type Loading.
Frequencies of Uniform Beams With Additional Masses.
Response of Timoshenko Beam to Random Process.
Impact Deformation of a Cantilever Beam.
Creep Deflections and Stresses of Beam-Columns.
Prediction of Creep in Bending From Tension—and Compression-Creep Data When Creep Coefficients Are Unequal.

### BEARINGS, LUBRICATION, LUBRICANTS

Self-Excited Vibrations of an Air-Lubricated Thrust Bearing.
Effect of Heat Conductance on Slider-Bearing Characteristics.
Influence of Load and Thermal Distortion on the Design of Large Thrust Bearings.
Oil Seals to Provide Positive Lubrication on Large or High-Speed Thrust Bearings.
Behavior of the Lubricating Film and Side Leakage in Dynamically Loaded Bearings.
Solution of Reynolds' Equation for Finite Journal Bearings.
Theoretical and Experimental Analysis of Hydrodynamic Gas-Lubricated Journal Bearings.
Viscosity-Pressure Effect on Friction and Temperature in a Journal Bearing.
nfluence of Pressure and Temperature on Oil Viscosity in Thrust Bearings Oil-Whip Resonance.
Theory of Oil Whip for Vertical Rotors Supported by Plain Journal Bearings.
Static and Dynamic Characteristics of Compensated Gas Bearings.
Solution of the Tapered-Land Sector Thrust Bearing.
Experiments on Imperfect Lubrication.
Theory of Lubrication in Short Journal Bearings With Turbulent Flow.
Oil-Film Properties for Unbalance Vibration Calculations.
Effect of Spin on a Rolling Elastic Sphere.
Effect of Tangential Contact Force on a Rolling Elastic Sphere.
Hydrodynamic Lubrication of a Roller Bearing.

### BOILER, BOILER FURNACES

Calculation of Theoretical Flame Temperatures in Furnaces.
Heat-Transfer Studies of Naval Boilers.
An Investigation of the Variation in Heat Absorption in a Pulverized-Coal-Fired Slag-tap Steam Boiler.
Dynamic Analysis of a Boiler.

### BUCKLING

Buckling of a Thin Plate Under Uniform Compression.
Buckling of Struts of Variable Bending Rigidity.
Buckling of Shallow Shells Under External Pressure.

### CAVITATION

Accelerated Field Tests of Cavitation Intensity.
Progress Report on Standardization of the Vibratory-Cavitation Test.
An Index of Cavitation Erosion by Means of Radioisotopes.
Cavitation and Nuclei.
Study of Corrosion and Cavitation-Erosion Damage.

### COMPRESSORS

Equivalent Performance Parameters for Turboblowers and Compressors.
On the Art of Designing Compressor Foundations.
Recovery Ratio—A Measure of the Loss Recovery Potential of Compressor Stages.
Stall Propagation in a Cascade of Airfoils.
Work Capacities of Energy Storage Systems on Basis of Unit Weight and Unit Volume.
Effects of Stage Characteristics and Matching on Axial-Flow-Compressor Performance.

### CORROSION

Formation of Sulphuric Acid in Boiler Flue Gases.
Effect of Temperature Variation on Composition, Fouling Tendency, and Corrosiveness of Combustion Gas From a Pulverized-Fuel-Fired Steam Generator.
Sulfuric Acid Corrosion in Oil-Fired Boilers.
Investigation of Erosion and Corrosion of Turbine Materials in Wet Oxygenated Steam.

### CREEP OF MATERIALS

Prediction of Creep in Bending From Tension- and Compression-Creep Data When Creep Coefficients Are Unequal.
Torsion in Presence of Steady Creep.
Theory of Elastic, Plastic, and Creep Deformations.

### COMPUTERS, ELECTRIC ANALOGY

Application of the Analog Computer to Product Dynamic Performance in Typical Hydraulic Circuits.
Design of a Self-Optimizing Control System.
Analog Study of a High-Speed Recording Servomechanism.
Dynamic Characteristics of Cam Forms Calculated by the Digital Computer.
Dynamic Study of an Experimental Pneumatic Process-Pressure Transmitter.
Performance Prediction for a Process Heat-and-Power Complex by Resistance Concept.
Contribution to the Stability Theory of Systems of Surge Tanks.
Temperature Distribution in Fins and Other Projections, Including Those of Building Structures, by Several Procedures.
Accurate Solutions of Partial Differential Equations.
Continuous Measurement of Characteristics of Systems With Random Inputs: A Step Toward Self-Optimizing Control.

### CYLINDERS, PRESSURE VESSELS

Overstrain and Bursting Strength of Thick-Walled Cylinders.
Reflection of an Acoustic Step Wave.
Effect of Curvature on the Hertz Theory for Cylinders
End Problem of Cylinders.
Stresses in a Thick Cylinder Having a Square Hole
Bursting Pressure of Cylindrical and Spherical Vessels
Test of the Epstein Equations for Cylinders
Stress Distribution in Rotating Disks and Cylinders.
Stress Distribution in Rotating Disks and Cylinders Under Elevated-Temperature Creep Condition.

### ELASTICITY

Propagation of Cracks and the Energy of Elastic Deformation.
Displacement Discontinuity in Elastic Half-Space.
Spherical Symmetry in Theory of Elasticity.
Displacement Discontinuity Between Two Dissimilar Solids.
Contact Stresses Under Pressure and Twist.
Refined Theory of Elastic Orthotropic Plates.
The Wedge Under a Concentrated Couple.

### FLOW OF FLUIDS

Convection Heat Transfer and Pressure Drop of Air Flowing Across In-Line Tube Bank.
Heat Transfer From a Rotating Cylinder With and Without Crossflow.
Heat-Transfer Characteristics of the Rotational and Axial Flow Between Concentric Cylinders.
Laminar Flow Over an Enclosed Rotating Disk.
On the Stagnation of Natural-Convection Flows in Closed-End Tubes.
Laminar Mass and Heat Transfer From Ellipsoidal Surfaces of Fineness Ratio 4 in Axisymmetrical Flow.
Recovery Ratio—A Measure of the Loss Recovery Potential of Compressor Stages.
A Study of Heat Transfer and Pressure Drop Under Conditions of Laminar Flow in the Shell Side of Cross-Baffled Heat Exchangers.
Heat Transfer to Fluids With Low Prandtl Numbers for (1) Flow Across Plates and Cylinders of Various Cross Section and (2) Flow Through Tube Bank.
Experimental Velocity and Temperature Profiles for Air in Turbulent Pipe Flow.
Modes of Adiabatic and Diabatic Fluid Flow in an Annulus With an Inner Rotating Cylinder.
Boundary Layer Along Annular Walls in a Swirling Flow.
Stall Propagation in a Cascade of Airfoils.
Losses in Flow Normal to Plane Screens.
Transition From Laminar to Turbulent Shear Flow—A Review of Some Recent Advances in Its Understanding.
Flow Characteristics of a Multiple-Cell Pump Basin.
Prediction of Flashing Water Flow Through Fine Annular Clearances.
Thermal Transfer in Turbulent Gas Streams—Effect of Turbulence on Macroscopic Transport From Spheres.
Effect of Wakes on the Transient Pressure and Velocity Distributions in Turbomachines.
Possible Similarity Solutions of the Laminar, Incompressible, Boundary-Layer Equations.
Boundary Layer on the End-Wall of a Turbine Nozzle Cascade.
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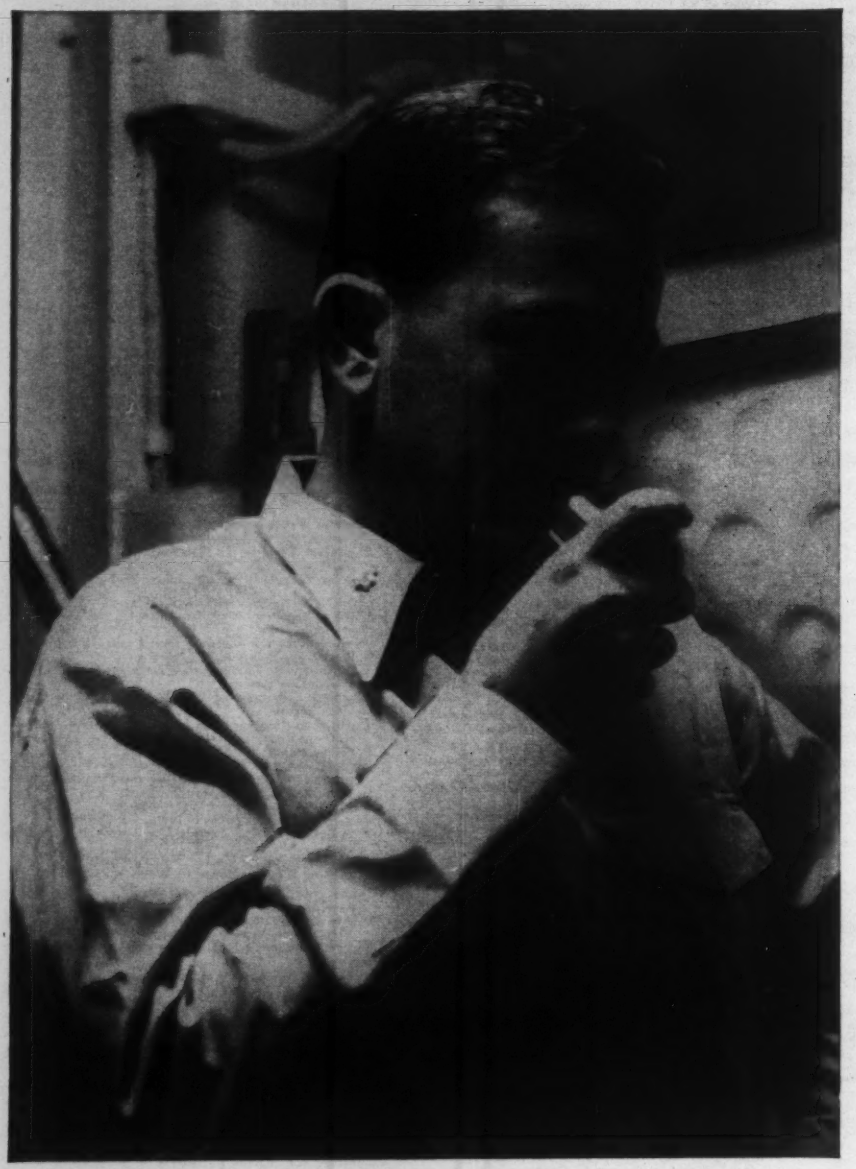

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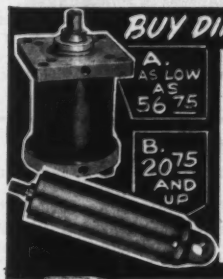


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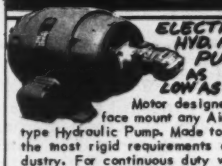

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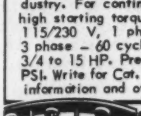

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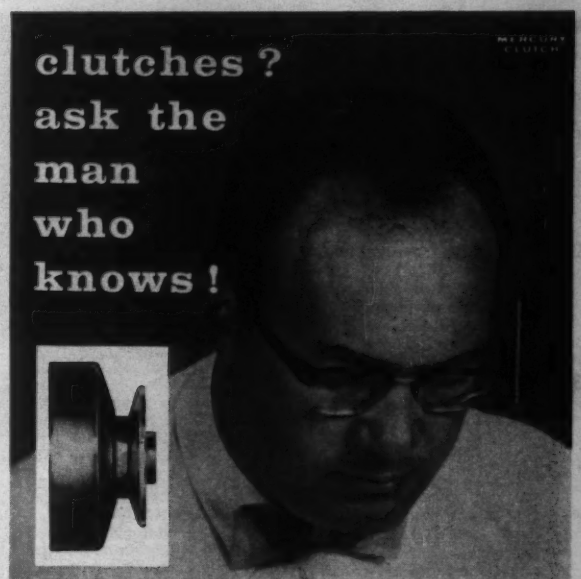

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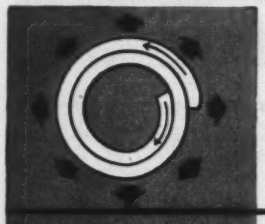

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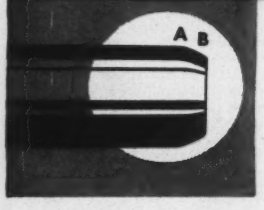


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**NON-HEAT-TREATED METALS** can be specified in standard SPIROL pins for extra corrosion-resistance or conductivity. Less resilient metals are usable because stress is evenly distributed throughout the spiral cross-section, giving maximum spring action.

**FREE!** *Write for literature on Spirol Pins.*

**SPIROL PIN**

C.E.M. COMPANY • 135 SCHOOL ST., DANIELSON, CONN.

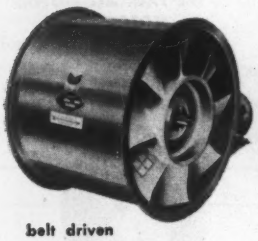
# NEW 8 blade

Aerovent FANS

# tubeaxial fans

## high speed - high efficiency

Aerovent's new Tubeaxial Fan, designed around a new 8-blade "Macheta" Airfoil Axial Flow Propeller, offers top performance against medium pressures at speeds to 3450 RPM. Available in 16", 18", 24", and 30" diameters, this unit combines speed, stamina and modern functional design. Easily installed in present ductwork or engineered to new construction, it's the right answer for resistances to 4" SP. Another outstanding development from Aerovent—America's finest industrial fans and air equipment.



belt driven

direct connected

WRITE FOR FREE BULLETIN 350

Air deliveries of Aerovent equipment determined in accordance with established and accepted codes and guaranteed by manufacturer.

CERTIFIED PERFORMANCE

Aerovent FANS

Aerovent FAN COMPANY, INC.

ASH and BEACH STS. PIQUA, OHIO



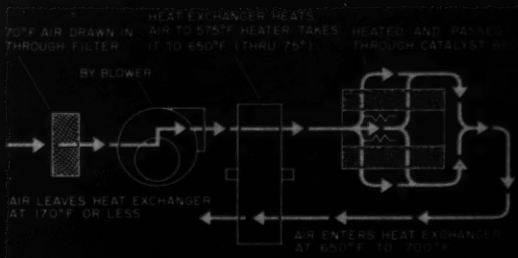

HEAT EXCHANGER HEATS AIR TO 575°F HEATER TAKES IT TO 650°F (THRU 75°)
HEATED AND PASSED THROUGH CATALYST BED
BY BLOWER
AIR LEAVES HEAT EXCHANGER AT 170°F OR LESS
AIR ENTERS HEAT EXCHANGER AT 650°F TO 700°F

Diagram shows how air is purified in nuclear subs. In this system designed by Desomatic Products, Inc., air is heated and passed over a catalyst bed, then recooled. A compact, rotary Air Preheater recovers enough heat from the exhaust to boost incoming air 500° F. A supplementary 6 kw heater is used. Without the heat exchanger a 40 kw heater would be needed, plus heavier air conditioning equipment.

# COMPACT, NEW HEAT EXCHANGER

*Sizes from 11" x 20" to 13" x 55"; handles up to 400,000 cu ft per hr*

This compact new heat exchanger owes its unmatched efficiency (up to 90%) to the *rotary* heat exchange principle. That is, the elements rotate continuously through the hot exhaust gases and the incoming air. Because the heat does not have to pass *through* the heat-exchange medium, maximum recovery is possible.

Capacity of this new rotary unit ranges up to 400,000 cu ft per hour in sizes up to 13" x 55". Pressure limit is one atmosphere . . . top temperature approximately 1000° F. (Models are adaptable for higher temperatures and pressures). Durability is built in, too. Stainless steel heating elements insure corrosion resistance; carbon-graphite seals insure effective sealing even at top temperatures.

This new unit is so compact, so reliable that it's now serving on U.S. nuclear subs (see diagram). Heavy-duty shock-resistant submarine model weighs only 190 pounds; commercial models significantly lighter.

***FREE DATA ON REQUEST***

Write for details. For information on larger units, please specify application. Air Preheater makes heat exchangers ranging in size from these compact models up to units big enough to serve public utility boilers. (90% are Air Preheater equipped.) But, big or small, the problems of recovering Btu's are much the same. And putting waste heat back to work for you can save fuel dollars; increase productive capacity; cut operating costs. So, write today to:

**THE AIR PREHEATER CORPORATION** *60 East 42nd Street, New York 17, N. Y.*

FALK All-Motor Motoreducers driving pipe conveyors in seamless tube mill.

Photo courtesy of
The Colorado Fuel and Iron Corporation

# You get these "extras" when you buy FALK *all-steel* Motoreducers

1. **Freedom from damaged housings.** The exclusive FALK *all-steel* construction gives full protection from cracked housings or torn-off feet...plus twice the ability of cast iron to maintain vital alignment.
2. **12-15% reserve load-carrying capacity** in the gears, by AGMA standards. The extra-depth, high pressure angle helical gears are another FALK exclusive ...they assure better operation and longer gear life.
3. **Highest known gear efficiency**—98½% per gear train under full load! This means maximum productive work for your power dollar.
4. **Longer service life**...advanced FALK design makes it possible to machine both bores for each shaft assembly at one time, thus eliminating possible accumulation of tolerances that occurs when individually machined parts are assembled. The result—better alignment of revolving elements that permits units to transmit rated capacity longer.
5. **Standard units to fit your needs.** Integral and All-Motor® Motoreducers are available in horizontal, vertical and right angle types...a type for every use.

Units are available up to 75 hp; output speeds from 780 rpm down to 1.2 rpm. Prompt delivery from factory, warehouse or distributor stocks. Ask your FALK Representative or Authorized FALK Distributor for *Bulletin 3100.*

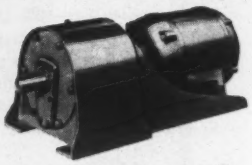
**THE FALK CORPORATION, MILWAUKEE 1, WIS.**

*MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS*

**Representatives and Distributors in most principal cities**

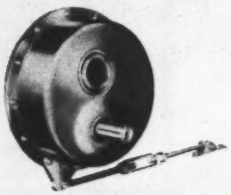
**FALK**

...a good name in industry



**THE FALK ALL-MOTOR® MOTOREDUCER**
**the original All-Motor unit**

(Shown) Horizontal concentric model. Also available in right angle and vertical types.



**THE ALL-STEEL FALK® SHAFT MOUNTED DRIVE**

Proved best for the countless industrial applications where a reducing unit mounting directly on shaft of the driven machine is indicated.

Units from 1/2 to 50 hp. Ratios —4:1, 14:1 or 24:1. Torque capacity up to 41,000 lb-in (in standard units). Prompt shipment from stock. For details, ask for *Bulletin 7100.*

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positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES: Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $4.00 a line. $2.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display advertisements carried in single column units of multiples of one inch at flat rate of $40.00 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

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Address CA-6688, care of "Mechanical Engineering."

### Mechanical Engineers
***Interested In Nuclear Engineering***

Opportunities for graduate mechanical engineers in our expanding nuclear engineering activities.

These positions involve comparative analytical and economic studies, application to the generation of power, and the engineering and design of electric generating plants using nuclear energy.

Requirements are experience in steam power design plus nuclear engineering courses. Nuclear experience would be desirable. Preferred age is 25 to 35. Nuclear engineering training will be provided.

*Location is the Loop (downtown) area in Chicago. A liberal program of benefits is offered. Salaries will be commensurate with background and experience.*

All replies will be confidential. Please send a complete resume of education and experience, and salary requirements, to:

**J. B. Christerson**
**SARGENT & LUNDY**
**140 S. Dearborn St., Chicago 3, Illinois**

## CRYOGENIC ENGINEERING

This industrial research organization has openings at Cambridge for mechanical and chemical engineers to work in research and development in gas liquefaction and processing. Work will include basic thermodynamic cycle analysis, fluid mechanics, experimentation and pilot operation, insulating systems, design of complete systems, process instrumentation, thermal stress analysis, and mechanical design.

ADL is currently engaged in missile work and in research and development of gas liquefaction, storage, and handling systems for industry and Government.

Applicants must have B.S. degree plus at least five years in industry or equivalent. Experience in design and fabrication of process equipment helpful.

*Send resume to* CHARLES T. SCHOCK.

**Arthur D. Little, Inc.**
ENGINEERING DIVISION
CAMBRIDGE 40, MASSACHUSETTS

## MECHANICAL ENGINEER

Company: Major meat processor with national distribution of over 1,000 meat products, The Rath Packing Company, Waterloo, Iowa, needs a man in Engineering Development.

Duties: Design food processing and packaging equipment; assume responsibility for development projects.

Experience: Mechanical Engineering Degree; three years' experience in design.

**Contact Mr. R. L. Bonwell, Manager of College Employment, The Rath Packing Company, Waterloo, Iowa.**

## MECHANICAL ENGINEERS

For challenging positions in Mechanical Engineering Section of one of the leading processors of corn and soybeans. Positions involve mechanical and structural projects covering changes, improvements and additions to plant processes and buildings. Have openings ranging from beginning position for inexperienced B.S. graduate to position calling for 3 to 8 years' experience.

Growth and development opportunities with research minded company in expanding industry located in modern midwest city of 80,000.

For information send resume to G. M. Prust.

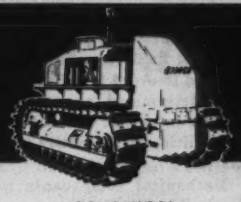
**A. E. Staley Manufacturing Company, Decatur, Illinois.**

## CRANE ENGINEER

A leading Truck Crane manufacturer needs an experienced Crane Engineer for field work-product evaluation. Relocation to St. Paul area and substantial travel obligations are requirements of the position.

Background must include definite experience in Crane and/or Crane Carrier component design with emphasis on practical field applications. Salary open. This newly created position is well worth your inquiry. Send complete resume to:

**AMERICAN HOIST & DERRICK COMPANY**
**63 SO. ROBERT ST., ST. PAUL, MINN.**



### MECHANICAL DESIGN ENGINEERS

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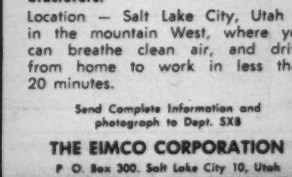
**Permanent positions open, for those qualified, with one of the nation's fastest growing heavy machinery manufacturers.**

Location — Salt Lake City, Utah — in the mountain West, where you can breathe clean air, and drive from home to work in less than 20 minutes.

Send Complete Information and photograph to Dept. SXB

**THE EIMCO CORPORATION**
P. O. Box 300, Salt Lake City 10, Utah



**MECHANICAL ENGINEERS, THERMODYNAMICISTS, CHEMICAL ENGINEERS AND PHYSICISTS, with fluid dynamics background**

# THE AIRCRAFT REACTOR IS CREATING A NEW REGIME IN HEAT TRANSFER AND HOT MACHINERY DESIGN

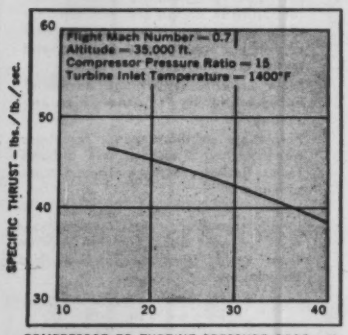
**PAUL E. LOWE,** *Manager, Thermodynamics and Mechanical Development for General Electric's Aircraft Nuclear Propulsion Dept. explains some of the new design parameters encountered on this pioneering program to an engineer with a background in conventional propulsion systems.*

**Q.** ***Mr. Lowe, what are the new parameters affecting heat transfer design for the aircraft nuclear power system?***

**A.** I can give you an indication, Mr. Albans, though specific data in this area is classified.

We are working here with a non-homogeneous reactor of new design. The big overall problem is to get all parts of the heat generating core working as near maximum as possible. The heat difference in the reactor between the hottest spots and the bulk fluid temperature must be reduced in order to deliver power, at a pre-determined temperature, to the turbine inlet that will utilize the full capabilities of the entire propulsion system.

Mechanical components must be developed with maximum strength to weight ratios. As you can see, these are real challenges to the engineer.




**Small pressure drop between compressor discharge and turbine inlet means high specific thrust.** Typical curve for a hypothetical direct-cycle turbojet aircraft propulsion system shows lowering of specific thrust with increasing pressure drop through reactor and shield ducting system. High turbine-inlet temperature also contributes to high specific thrust.

**Q.** ***What about thermal stress?***

**A.** Here again, I can't give you figures. However, a reactor of the small size and high power density which the weight limitations of an aircraft application make obligatory, develops temperature gradients that are more severe than those engineers, in other reactor systems, have encountered. This gives the nuclear designer new thermal stress parameters to work with.

*Also new reactor materials have had to be developed* at ANP to withstand the high temperatures and radiation conditions encountered.

**Q.** ***Then additional new parameters result from the use of new alloys, cermets and coatings?***

**A.** That is so, Mr. Albans. An ANP design engineer is working in a field that is still embryonic in learning how to fully exploit high strength, and therefore brittle, materials in structural shapes, and mechanical devices. We must become sophisticated in such designs.

Considerable advances have been made here, however, in the design of really high temperature mechanical components and structures. This requires ingenuity and competent analysis to achieve technical understanding and permit operation at very low stress levels.

**Q.** ***Mr. Lowe, can an engineer work effectively on mechanical design and thermodynamic problems at ANP without previous training in nucleonics?***

**A.** Certainly. The engineer we want to join our staff is one who has high intelligence, plus the capability to apply what knowledge he already has. We want top performers in native mental abilities with sound basic technical background.

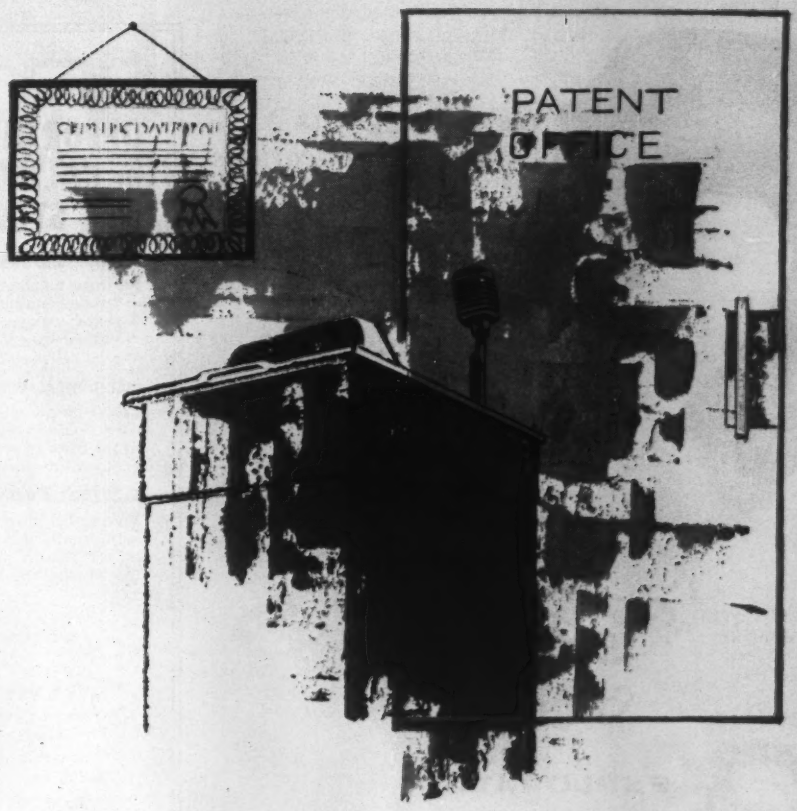
**Openings for MECHANICAL ENGINEERS, THERMODYNAMICISTS, CHEMICAL ENGINEERS *and* PHYSICISTS (with fluid dynamics background). Nuclear experience is not required. Necessary training and information in nucleonics will be provided through in-plant seminars, contact with associates and graduate courses at the University of Cincinnati on General Electric's 100% Tuition Refund Plan. Write in confidence including salary requirements, to: Mr. Paul E. Lowe, Division 41-MF, Professional & Technical Personnel.**

**AIRCRAFT NUCLEAR PROPULSION DEPARTMENT**

**GENERAL ELECTRIC**

P.O. Box 132 · Cincinnati 15, Ohio

**A few openings in other areas of the program for: Nuclear Engineers • Metallurgists • Physical Chemists • Solid State Physicists • Ceramists**

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This is but one phase of our work in providing research and design support for Automatic Electric and other affiliated manufacturing units of General Telephone & Electronics Corporation.

We are interested in engaging the services of a limited number of Physicists, Electrical Engineers and Mechanical Engineers with experience in Logical Circuit and System Design, Memory Devices, High-Frequency Pulse Techniques, Electronic Switching, Component Packaging and Electromechanical Design. If you are interested, write in confidence to Mr. Robert Wopat, President, General Telephone Laboratories, 200 Wolf Rd., Northlake, Illinois.

**General Telephone Laboratories**

GENERAL SYSTEM

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Engineers

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**MECHANICAL TUBE ENGINEERS**

Perform mechanical design & test of tubes, components and tooling. 5 years' experience in mechanical design, testing & evaluating special purpose tubes.

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Electromechanical design of electronic equipment. Background in microwave systems & antennas desirable.

**ELECTRONIC PACKAGING**

Packaging of airborne electronic subminiaturized equipment. 7 or more years' experience in electromechanical packaging of electronic equipment desired.

*Please send resume to Mr. Wayne Pearson*

SYLVANIA ELECTRONIC SYSTEMS
A DIVISION OF SYLVANIA ELECTRIC PRODUCTS INC.

P.O. Box 188
Mountain View, California
*On the San Francisco Bay peninsula*

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## MECHANICAL ENGINEERS

**The Equipment Engineering Section of the West Virginia Pulp and Paper Company has immediate openings for Mechanical Engineers at their Research and Development Laboratories located at Covington, Virginia.**

**JUNIOR PROJECT ENGINEERS**

**Requires degree in mechanical engineering with or without experience. Age to 30.**

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**Requires degree in mechanical engineering and experience in the machinery field or the paper industry. Age to 35.**

**These positions require versatility, creativity, and a high degree of mechanical ability to do responsible project engineering work. Working field: Paper converting and finishing machinery. Willingness to travel between plants is essential.**

**Salaries open.**

**Send complete résumé in confidence to—**

**Research Director**
**WEST VIRGINIA PULP AND PAPER COMPANY**
**Covington, Virginia**

# idea:

Submarines can hide within range of helicopter-borne sonar by "riding the thermocline"—a water temperature change that casts shadows in sonar search patterns. Precise temperature-vs.-depth records allow the operator to spot thermoclines and change his search pattern to look into the shadows. Existing gear "worked", but it took too long and could not define the shadow zones very accurately. TI engineers created an automatic recorder, the bathythermograph, more accurate than a laboratory thermometer, that gives results instantly where they were needed—in the helicopter. Small as a portable typewriter, it easily fits with the sonar into the space available.

RESULT: Same sonar—fewer missed submarines.

*design, manufacturing and quality engineers—3-10 years experience*

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We require a steady influx of exceptionally-qualified men in these technologies. To learn more about us and how we can fit into your career plan, write for a copy of "We can tell you this much about Apparatus division" to:

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Creative people at IBM are hard at work on a problem that has vexed man since the dawn of history — communication with his fellow beings. One group of scientists and engineers, for instance, is working on multiplexing techniques to channel data. This data has to be made available at desired times and places. Another group is developing computer systems that will control complete warehousing or industrial operations. Careers in data communications are available at IBM in these areas: circuit design & research, computer analysis & design, cryogenics, industrial controls, inertial guidance, information theory, mathematics, optics, semi-conductor design, and solid state.

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**For details,** write, outlining background and interests, to:

**Mr. R. E. Rodgers, Dept. 598F**
**IBM Corporation**
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Write: W. R. Pulhamus, Head, Electrical Technology Dept. or B. G. Davis, Head, Mechanical Technology Dept.

**MOHAWK VALLEY TECHNICAL INSTITUTE**
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**Utica, New York**
**Tel. RE 3-0451**

**CHIEF MECHANICAL DESIGN ENGINEER**

We are in immediate need of a Mechanical Design Specialist for assignment to our Los Angeles office.

Candidate should possess a minimum of 10 years' experience in design of plumbing; process piping; H & V; air conditioning; above and below-ground utilities; industrial equipment layout & design; instrumentation & controls. Some field experience desirable.

All replies will be be kept in strictest confidence.

Forward resume to
Mr. John A. Oliver

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Please apply by letter, giving details of your training and experience, by writing to CA-6707, care of "Mechanical Engineering."

*Professional Personnel Requisition*

# Controls & Instrumentation Engineers

Marquardt Aircraft—a leader in air and space propulsion and control systems, high altitude rocket research and weapon support systems—offers a creative engineering environment in which you will find significant active projects. These include engine control systems for nuclear turbojet, inlet control systems for the North American F-108 and Hound Dog missile, control systems for the supersonic ramjet engine, feasibility studies of advanced and unique engine cycles, nozzle control for advanced ballistic missile components and other power system actuators. These control units include fluid and gas operated servo systems suited for environments above one thousand degrees.

If you are an engineer experienced in fluid dynamics or fluid operated controls and interested in mechanisms designed for severe environmental conditions, you should consider one of the following engineering opportunities at Marquardt:

**CONTROLS DESIGN**

To create components for pneumatic and hydraulic control systems. Work ranges from simple piston actuators to complex speed computing devices. All designed for high sensitivity, fast response, extreme environmental conditions and light weight. Should be experienced in machine design and have an understanding of basic design analysis.

**CONTROLS ANALYSIS**

To investigate aircraft and missile control problems through the application of analysis methods in mechanics and dynamics, heat transfer, compressible flow, and servomechanisms. Position offers opportunity for creative engineering.

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Opportunity to create workable controls components. Must have a "feel" for hardware and desire to undertake broad engineering responsibility. Opportunity to solve "on-the-spot" engineering problems utilizing pneumatic and hydraulic control analysis techniques.

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Implement, establish and/or originate the use of standards both design and hardware for reduction of time and cost of engineering effort. Must have knowledge of hydraulic and pneumatic design and components. Should be capable of setting up an evaluation program as required. Requires ability to work with many engineering groups both in advisory and service capacity.

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To predict reliability of control of units and recommend appropriate design changes. Knowledge of servomechanisms and feedback theory desirable. Should have background in statistics and experience in reliability field.

**INSTRUMENTATION**

Specification and design of instrument components and systems for ground testing of supersonic ramjet engines, jet engine components, inlet controls, nuclear powerplant controls and emergency power units. Prefer instrumentation experience, including data acquisition and processing equipment. Familiar with process control systems.

**For additional information, please write**

**Mr. Floyd E. Hargiss, Manager**
**Professional Personnel, Dept. K-2**
**Marquardt Aircraft Co.**
**16555 Saticoy Street**
**Van Nuys, California**

Marquardt AIRCRAFT CO.

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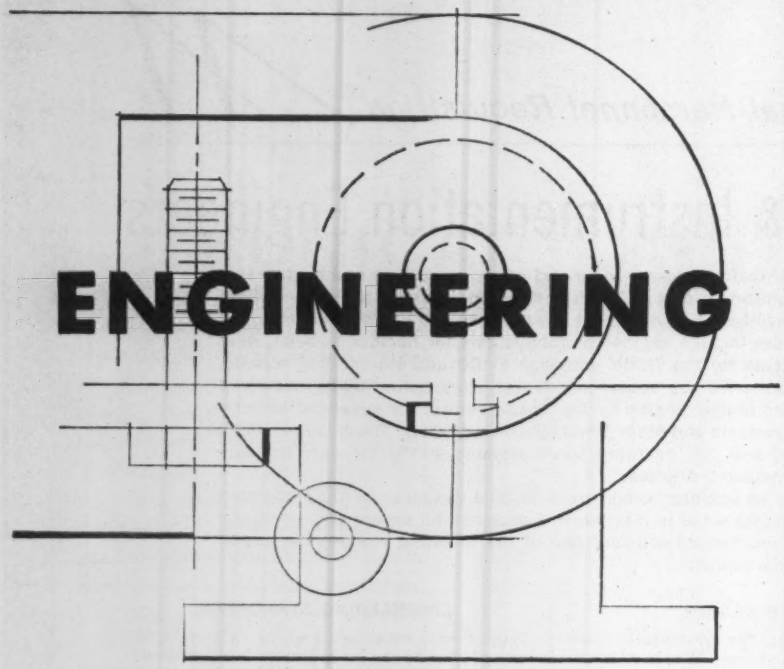
*COOPER DEVELOPMENT CORP.—MONROVIA, CALIFORNIA—A MARQUARDT SUBSIDIARY*

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**For employment information, write to: Personnel Director**
**Division 59-56**

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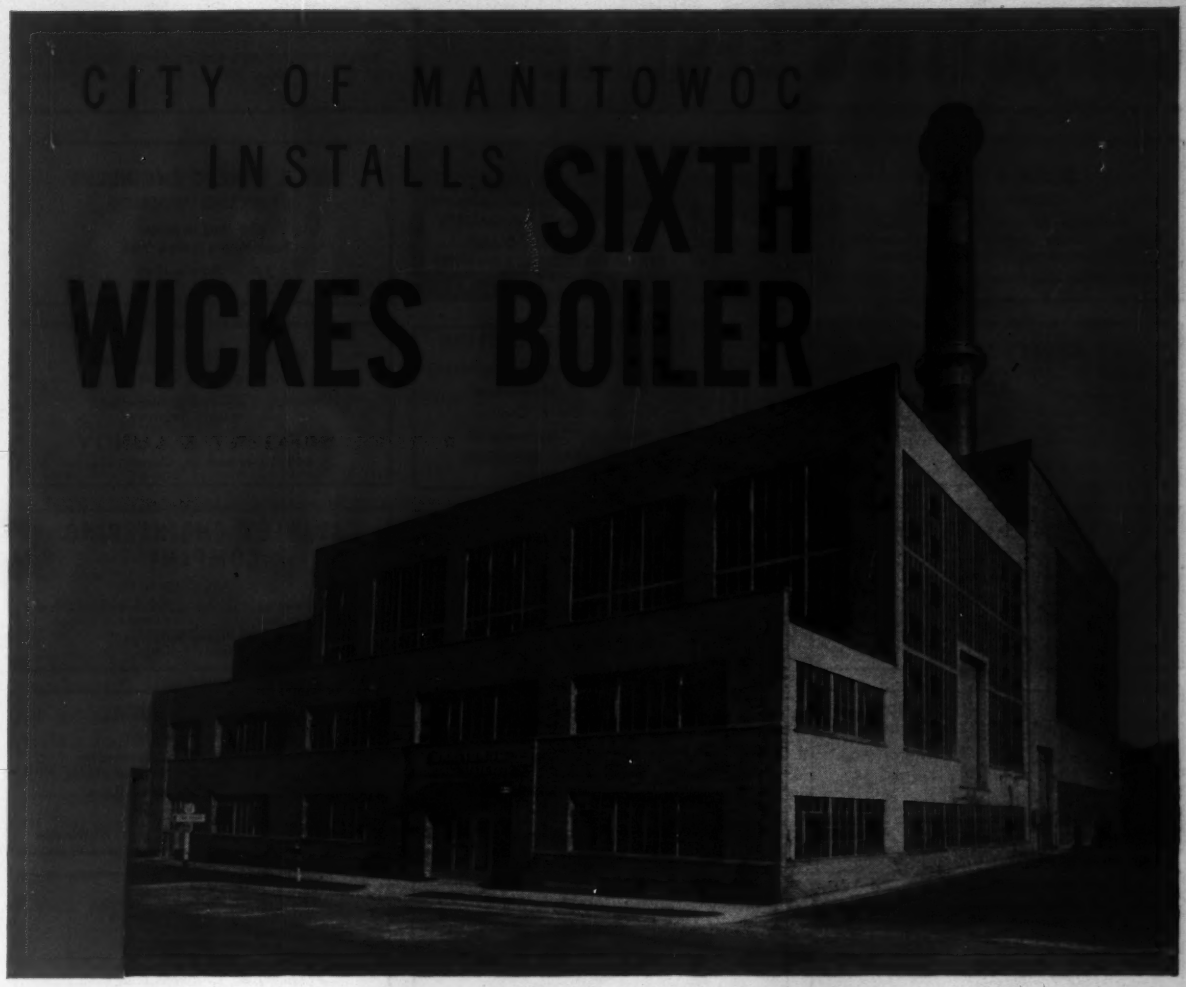


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THIS HUGE pressure vessel—believed to be the largest ever built—was conceived for the extremely high operational requirements of 30,000 psi and test pressure of 45,000 psi.

Designed and built by Loewy-Hydropress Division of Baldwin-Lima-Hamilton for the United States government, this unusual piece of equipment required an elaborate testing procedure comparable in precision to the observation of a patient's heart during a surgical operation.

More than 80 SR-4® strain gages, products of B-L-H's E&I Division, were located at all critical points of the structure. Over 1500 readings were taken of the strains and stresses developed during loading the vessel up to 45,000 psi and down again.

Measurements obtained during this procedure were used for both the analytical computations and the graphical plotting of stress-strain diagrams required to describe the successful acceptance tests.

Fabrication and testing were performed entirely at B-L-H's Eddystone Division—another demonstration of the integrated inter-divisional facilities of the Baldwin-Lima-Hamilton Corporation.

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